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CONTENTS.

An Asterisk (*) denotes an illustrated article.

OFFICIAL NOTICES—

The Thirty-first Annual Meeting of the New England Association of Gas Engineers..... 201

Eighth Annual Meeting, Michigan Gas Association..... 201

EDITORIALS—

Briefly Told..... 202

The Meeting of the New England Association of Gas Engineers—The Meeting of the Michigan Gas Association—Notes.

Regulating the Air Supply to Burners Consuming Mixed Coal and Water Gas, by Mr. H. L. Greville, F.C.S..... 202

*The Lighting of City Streets, by Mr. E. C. Jones..... 203

A Century of Engineering, by Mr. W. A. Bole..... 205

Education and Competition..... 208

The Coming Exhaustion of Nature's Stores..... 209

Desirability of Using Storage Batteries in Medium Size Stations..... 211

Are Municipal Electric Lighting Plants Profitable? by Mr. M. J. Francisco..... 211

ITEMS OF INTEREST FROM VARIOUS LOCALITIES..... 212

The Dover (N. J.) Proposed Gas Company—Gas Works for Traverse City, Mich.—Personal—Capital Stock Increase, Redlands, Cal.—Mr. R. S. Berlin Appointed Gas Inspector for Omaha, Neb.—Death of Capt. Jno. Davitt—Annual Meeting, Bowling Green, Ky.—Annual Meeting, Bellingham Bay Company, Wash.—Mr. John Neth Takes Charge at Norwich, Conn.—Annual Meeting, Washington, D. C.—Mr. M. Britsch Promoted—Some Proposed Legal Matters, Wilmington, Del.—Resignation of Mr. C. Watson—Messrs. Baxter & Young Buy the Bucyrus (Ohio) Plant—A Proposed Massachusetts Bill—Annual Meeting, San Francisco, Cal.—Annual Meeting, Coldwater, Mich.—The Quality of Lynchburg (Va.) Gas—Sale of the Petersburg (Va.) Plant—Annual Meeting, Charlestown, Mass.—Public Lighting, Denver, Col.—And Many Other Items.

The Market for Gas Securities..... 214

[OFFICIAL NOTICE.]

The Thirty-First Annual Meeting of the New England Association of Gas Engineers.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS,
OFFICE OF THE SECRETARY,
NEW BEDFORD, MASS., Feb. 6, 1901.

To the Members of the New England Association of Gas Engineers: The thirty-first annual meeting of this Association will be held at Young's Hotel, Boston, Mass., on Tuesday and Wednesday, February 19th and 20th, 1901—note change of opening day from Wednesday to Tuesday. The meeting will convene in room 12, at 10 o'clock, A.M., Tuesday, and members are requested to gather promptly, as the time of the meeting promises to be fully occupied. The following papers are promised for reading:

"Remarks on Purification;" by Mr. S. J. Fowler, Springfield, Mass.

"The Proportion of Sulphur Removed in Each Purifying Box;" by Mr. Carroll Miller, Newark, N. J.

"Some Sketches of Gas Governors;" by Mr. J. J. Humphreys, Jr., Worcester, Mass.

"Selling Gas;" by Mr. C. J. R. Humphreys, Lawrence, Mass.

"A Test of a Gas Engine Electric Lighting Plant;" by Mr. H. N. Cheney, Boston, Mass.

"How They Do Things on the Other Side;" by Mr. F. H. Shelton, Philadelphia, Pa.

"Gas Lighting at the Paris Exposition."

Reports on "Inclined Retorts" and "Coke Ovens" up to date will be discussed, as well as "Gas Handling Plants," "Prepayment Meters," "Assisting Purification by Adding Oxygen," "Size of Mesh in Coke Screens," etc., etc.

The Question Box, as usual, will be a feature of the meeting, and members will do well to send their queries to the Secretary in advance, so they may be published and assigned to persons posted on the particular subjects. Members may obtain badges from the Secretary. The annual dinner will be held Tuesday evening instead of Wednesday. Application blanks for membership may be obtained of the Secretary, and all matters to come before the Directors should be in the Secretary's hands before February 18th. Annual dues should be remitted before the meeting.

Friends of the Association are cordially invited to attend the meeting.

N. W. GIFFORD, Secretary.

[OFFICIAL NOTICE.]

Eighth Annual Meeting, Michigan Gas Association.

MICHIGAN GAS ASSOCIATION,
OFFICE OF THE SECRETARY,
ANN ARBOR, MICH, Jan. 28, 1901.

To the Members of the Michigan Gas Association: The eighth annual meeting of the Michigan Gas Association will be held in Grand Rapids, Mich., on Wednesday and Thursday, February 20th and 21st. The headquarters will be in the Morton House, where the meetings will also be held.

The following papers will be presented:

"Neglected Opportunities;" by Mr. B. C. Cobb, Detroit, Mich.

"Inclosed Cluster Lights with Self-Igniters;" by Mr. A. L. Zwisler, Kalamazoo, Mich.

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"Street Maps: Their Use and Abuse;" by Mr. Paul Challis, Adrian, Mich.

"New Business:" by Mr. J. C. Sloan, Port Huron, Mich.

"The Relation of Heating and Illuminating Gases, Especially as Applied to Incandescent Mantles;" by Mr. Herman Russell—Mr. Russell is the bearer of the Michigan Gas Association Scholarship in the University of Michigan.

A number of short topics will also be offered and discussed.

The rates secured by the committee having the matter in charge, for the accommodation of the members and the Association's guests at the Morton House, are: $2.50, $3 and $3.50 per day—the last rate affording a room and bath. The best accommodations are always secured by writing in advance. HENRY W. DOUGLAS, Secretary.

BRIEFLY TOLD.

THE MEETING OF THE NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.—Secretary Gifford's preliminary notices of the thirty-first annual meeting of the New England Association, which number pointedly recalls the fact that the Mother Association is quite on in her fourth decade, have kept in the minds of the members that the journey to Young's would be well worth making. Regardless of such pleasant remembrance we venture to assert that none of those who will take part in this reunion were prepared for the plenty that is to be put before them. How many times have we all heard the cry or the plaint that our Associations must suffer from a technical point, in that the subjects that interest them had been gone over so many times! The cry or the plaint is well and volubly replied to by the list of papers that Secretary Gifford's final circular affords. It carries three topics, at least, that are new to the lists of Gas Association papers, and it is rather remarkable, and altogether creditable to the New Englanders, that the entire programme and schedule relate to gas matters. One omission unfortunately there is, and that is concerned with a failure to have a set paper on coke oven practice in New England. However, even that omission is not complete, since a report on "Coke Ovens, Up-to-Date" is to be presented. Take it all in all the programme is a really brilliant one from the gas maker's point of view; and such is the view point that has been held by the New England men, even since the first Jablochkoff note of triumph was sounded in Paris, France, in the Spring of 1878, when he foretold the doom of gas through and by the blazoning of the electric arc. However, the cold fact is that gas is still in the running, and it is undeniable that the common sense of the gas makers has enabled them to benefit much by the stumbles of their speedy though sprawling competitors. It will be noted that the dates of the New England meeting have been changed a trifle from the order prescribed by its laws. The regular time would have been the third Wednesday in February for the first day, with the dinner for that evening; but this year Ash Wednesday comes the 20th inst., and the Directors determined it would be more in line with observance that would meet the practice of all were the time brought a day forward. In connection with the meeting and the list of its attractions, sight should not be lost of the fact that the President (Mr. Walter R. Addicks) is to have an innings with an inaugural address, and in it we imagine—yes, more than imagine—that he will make mention of at least one topic that will hold the close attention of his hearers. The outlook for attendance at the meeting is excellent.

THE MEETING OF THE MICHIGAN GAS ASSOCIATION.—Secretary Douglas, through the columns of the JOURNAL, also reminds the fraternity that the eighth annual meeting of the Michigan Gas Association will be held in Grand Rapids on the 20th and 21st days of this month. It is a pity that the New England and Michigan meeting times clash; but such is the case, and there is an end of it. It is noteworthy that the Michigan's programme, so far as the regular list is concerned, quite resembles the New England listing in respect of the plenty of matter for ventilating gas topics shown in the naming of the papers. President Hyde, Secretary Douglas and the committee on preliminaries are to be congratulated on their advance work; and it goes without saying that the members will thoroughly enjoy the technical and social sides of the feast that has been prepared for them.

NOTES.—The organization of the Steelton (Pa.) Home Gas Company has been perfected. Its President is Mr. C. A. Sickles, and its Secretary is Mr. J. C. Durbin. The Company has the right to supply gas in the adjoining districts of Highspire, Oberlin, Swatara and Susquehanna. It is understood that construction work will be commenced in April.—It is reported that a proposition for the sale of the Springfield (Mass.) Gas Light Company is being seriously entertained by its present proprietors.—The municipal gas works of Santa Clara, Cal., have been completed, and gas is being supplied therefrom.

Regulating the Air Supply to Burners Consuming Mixed Coal and Water Gas.

[By MR. H. LEICESTER GREVILLE, F.I.C., F.C.S., in *Journal of Gas Lighting.*]

The Nineteenth Century has been an era of unsurpassed progress. To review in the briefest possible manner all that has happened, even in the limited domain of the development of the gas industry, would require the publication of at least a small treatise, in place of a brief article, in order to adequately represent the fullest importance of so large a subject.

Omitting minor considerations, there cannot be a doubt that the introduction of carburetted water gas on a large scale has been a distinct and radical change from the older procedure of the manufacture and supply of plain coal gas. Much might be said on this subject; but in the present article I have simply to offer a few remarks on one aspect of the question, and this a most important one—viz., that of the suitable regulation of the air supply to gas under the modified conditions of manufacture. Progress in the manufacture of water gas has been so rapid that the altered conditions necessary for heat and light development have not progressed at the same rate; so that at the present time the best means of obtaining the maximum effect possible have not been fully realized.

The circumstances are peculiar. Gas companies (acting with due consideration to the interests of themselves and their consumers) have adopted a radical change in manufacture. The new gas has been proved by scientific tests to be fully up to the statutory illuminating power as authorized by the official method prescribed by the highest experts. With regard to its heat value, the present mixture of coal gas and carburetted water gas is practically equal, or at least very little inferior, to plain coal gas.

Notwithstanding these scientific facts, it is undoubtedly the case that, in districts where carburetted water gas has been adopted as an adjunct to coal gas, there have been, in many instances, unsatisfactory developments from a consumer's point of view. Gas stoves, and even Welsbach burners, have started "roaring" or "flashing back." This is entirely due to the fact that the air supply has been adjusted for the coal gas previously in use, before the advent of water gas, and that neither the makers of heating nor of lighting appliances have recognized the need of radical but necessary alterations. The fault is not with the gas, but with the appliances for its use. In fact, it seems that the attitude of the purveyors of gas appliances might suggest that the old proverb—"Where ignorance is bliss 'tis folly to be wise," should be modified, as a practical application, to—"Where wisdom is bliss 'tis folly to be ignorant."

Comparing the composition of coal gas with that of water gas, the following figures have been taken as a basis. The authority is Professor Vivian B. Lewes, quoted by Herr Henri Sospisio, of Trieste, in a paper read before the International Gas Congress at Paris, and published in the *Journal* of Sept. 18, 1900. I give the figures verbatim:

	Ordinary Gas.	Carburetted Water Gas.
Hydrogen (H)	47.69	39.44
Marsh gas (CH_4)	35.75	16.99
Hydrocarbons ($C_n H_{2n}$)	4.88	8.23
Carbon monoxide (CO)	5.99	29.03
Carbon dioxide (CO_2)	....	....
Nitrogen (N)	4.76	6.20
Oxygen (O)	0.95	0.21
Lighting power in candles	22.3	22.7
Density (air = 1,000)	549	647.0

It would have been better to have contrasted a lower quality of coal gas with the higher quality of water gas; but for my special purpose, the comparison as it stands is sufficient.

The first step to ascertaining the proportions of air necessary for complete combustion, is to show the nature of the chemical changes involved. These are as follows (taking the $C_n H_{2n}$ as C_2H_4):

$$2\,H_2 + O_2 = 2\,H_2O$$
$$CH_4 + 2\,O_2 = CO_2 + 2\,H_2O$$
$$C_2H_4 + 3\,O_2 = 2\,CO_2 + 2\,H_2O$$
$$2\,CO + O_2 = 2\,CO_2$$

The proportions by volume of oxygen necessary for combustion, for 1 volume of the respective gases, are, from the above formula: H requires of O, 0.5 vol.; CH_4, 2 vols.; C_2H_4, 3 vols.; and CO, 0.5 vol. Calculating on these formulæ, and on the composition of the respective gases, we have the following figures:

	Coal Gas.	Oxygen Required.	Carburetted Water Gas.	Oxygen Required.
H	47.67 × 0 5 =	23.83	39.44	19.72
CH_4	35.75 × 2.0 =	71.50	16.99	33.98
C_2H_2	4.88 × 3.0 =	14.64	8.23	24.69
CO	5 99 × 0.5 =	2.99	29.03	14.51
Total oxygen required for complete combustion..		112.96		92 90

The net result showing that, whereas 100 volumes of coal gas require for complete combustion 112.9 volumes of oxygen, the proportion for carburetted water gas is 92 9—a net difference of 20 volumes, which, multiplied by 5 (taking the proportion of oxygen in air roughly as one-fifth) is equal to 100 volumes difference in the air supply for the two gases. On a basis of 50 per cent. of coal gas and water gas, the calculation would indicate that the air supply would be 50 volumes in excess of that required for coal gas only. It is therefore obvious that, on the most abstract scientific reasoning, burners manufactured on the basis of developing the best effects from coal gas would have an enormously excessive air supply when used for water gas, or even water gas and coal gas containing a large proportion of the former. Alterations in the respective volumes of the two gases would naturally modify the figures, but would leave the scientific basis of the matter untouched.

The practical effects of an excessive air supply are well known in scientific circles, although not sufficiently recognized. Burners intended to develop their maximum light from limited combustion, in which dense hydrocarbons are temporarily formed—such as flat flames and even argands—do not develop their maximum possible light; while with regard to heating burners especially designed for the best conditions of immediate and perfect combustion with the production of non-luminous flames, such as characterizes those used for heating stoves, and for the Welsbach incandescent burners, the proportions of air and gas come rapidly close to the point of absolute explosion. The first indication of this critical condition is the production of a roaring sound, resulting from a series of small and rapidly successive explosions. The least further excess of oxygen then has the effect of what is popularly known as a "flash back," in which the explosive mixture of gas and air can no longer maintain even its disturbed equilibrium at the burner outlet, but flames down the tube and ignites the gas jet at the burner inlet. Long before the period of the roaring or flashing back occurs, the air supply may have been in excess of that necessary for the production of the best effects, *quo ad*, the respective ratios of gas and air.

The remedy for this state of things is of so simple a character that it is a matter for wonder why the purveyors of gas appliances have not seriously considered the matter before. Possibly they were in ignorance of the requisite scientific data upon which to act. All that is necessary to meet the emergency is a limitation in the area of the holes regulating the air supply. In the case of Welsbach burners, the difficulty can be met in a simple way—viz., by slightly enlarging the small orifice which acts as the gas inlet. This can be done without necessarily increasing the consumption, which can be controlled as usual by the supply tap. A difficulty in the practical application of "old" and "new" gas might be suggested by the fact that the two different grades require, for the development of their best efficiencies, different ratios of gas and air supply. This apparent complication could, however, be easily overcome.

With regard to one large application of gas—its use for stoves for cooking and heating purposes—two classes could be issued by the manufacturers, designated by some brief but distinctive title, such as "A" and "B;" the one class being intended for districts where coal gas alone is supplied, and the other for areas where carburetted water gas has been adopted. It would not be difficult for gas companies to place orders for either class to meet their special requirements. As to the special question of the supply of water gas and the possible increase of its use in the future, the necessary modifications for its complete combustion in order to produce the best effects have, I hope, been clearly indicated.

With regard to the employment of gas in flat flame burners, the necessary modification to produce the best effects would be to employ burners with large holes, with a slow initial velocity of gas. It might be within the province of the present article to discuss, or to criticise, Mr. Dibdin's recent and painful experiences of the variations in illuminating value which he has obtained by subjecting gas of varying composition to the process of combustion in unsuitable burners, and noting, with the highest expenditure of scientific accuracy in photometrical practices, and elaborately designed diagrams, the eventual results. It has, however, been so long recognized as a fact that the so-called candle value of any particular gas depends on the conditions of testing, that any remarks on the subject are almost superfluous.

Mr. Dibdin assumes that the gas should be made to suit the burners, whereas the whole previous record of scientific research has been in the direction of making the burner suit the gas. A professional man may, in pursuit of his avocation, be called upon to test any grade of gas, within the possible variations of from 10-candle coal gas to as high as 60 candle oil gas. No scientific man with an accurate knowledge of his profession, and unprejudiced by bias, would dream of testing gas of different compositions and of varying illuminating power by the same burner; and where this has been done, even to a limited extent, no one can be expected to manifest either the slightest surprise at the results obtained, or the most limited enthusiasm on their publication. The methods explain the results. It is not, perhaps, judicious to jest over such a serious matter; but Mr. Dibdin's allegations against the carburetted water gas industry (and his figures practically amount to this) remind me of one of the "Ingoldsby Legends," in which the following couplet occurs:

> Never was heard such a terrible curse;
> But what gave rise to no little surprise
> Nobody seemed one penny the worse.

In conclusion, I can only say that I believe there is a large future for carburetted water gas. There are many reasons for its more extended adoption; and there is no doubt that, with a full recognition of the most advantageous methods of its combustion in order to produce the best effects of which it is capable, many prejudices will be dispelled, and it will take its right place—useful and economical alike to producer and consumer—as one of the leading features of the age in scientific progress.

The Lighting of City Streets.

[By Mr. E. C. Jones, Chief Engineer of the San Francisco Gas and Electric Company.]

In preparing a paper on such an important topic—a topic which affects the comfort and safety of communities—it is customary to use graphic illustrations, usually called exhibits.

Exhibit A.

Exhibit A is found in the streets of San Francisco, which are lighted by the Welsbach burners of 100-candle power each, placed in boulevard lanterns with opal tops to act as reflectors. These lights are placed at a diagonal separation of 180 feet, while the distance from center to center on the line of the street is about 160 feet. Thus lighted, the city of San Francisco is one of the best illuminated cities in the United States.

Under the provision of the new charter of San Francisco, the Supervisors are only permitted to contract for city lighting for one year. Previous to the introduction of incandescent gas burners the city streets were lighted by ordinary flat-flame governor burners, consuming 5 cubic feet of gas per hour, and giving a light of 20 candle power.

The Supervisors, in casting about for some better means to light the streets, discussed the various methods of electric lighting and their respective merits, and finally the San Francisco Gas and Electric Company offered to equip its lamp posts (over 4,500 in number) with Welsbach lights on a 1-year trial. The cost of the experiment was enormous to the Company, and the benefits to the city are equally enormous; but in converting so great a number of lamps for so short a period of time, about 2,900 of the old lanterns were painted with aluminum coating and provided with complete Welsbach burners with wind guards and arrangements for lighting, while about 1,800 of the highly ornamental boulevard lanterns were placed on the remaining lamp posts in the residence districts of the city, and on lower Market street two Welsbach burners were placed in each lantern, thus furnishing a light of 200-candle power. Should this new way of lighting the city streets become popular and satisfactory, arrangements have been made to displace the ordinary lanterns with those of the boulevard type.

In this connection it has been found more effective and desirable,

where a greater number of burners are needed, to increase the number of complete lanterns on each lamp post instead of multiplying the number of mantles within one lantern. Following out this idea, a number of clusters of 3 lanterns each are now on the way from the East to be erected on the streets of San Francisco to demonstrate their superiority over arc electric lights for street lighting. These clusters will have an illuminating power of 300 candles, and in addition to the increased light—which is as much, if not more, than the average actual candle power of arc lights—the clusters will add to the beauty of the streets, and be nearer the ground where the light is needed.

The principles of photometry, or the measurement of light, are well understood, and the almost universal standard employed is the sperm candle specially made to consume 120 grains per sperm hour. This standard is used to convey to the public mind the relative lighting values of illuminating agents, and from the inception of the gas business the quality of the gas has been known by its candle power which represents the amount of light (expressed in sperm candles) which can be obtained from 5 cubic feet of the gas burned during 1 hour.

In the infancy of the gas business the burners employed were crude and inefficient, consisting of simple jets of flame, and the candle power was correspondingly low, but by experience it was found that a greater candle power might be obtained from the same gas by improving the burner through which it was consumed, until skill and labor gave to the gas examiner what is known as the "Sugg-Argand burner" for photometric use. This burner was supposed to so regulate the supply of gas and air that complete combustion of the gas was assured, and as nothing better was known by which the highest candle power of the 5-feet gas would be developed, this form of burner had been accepted by nearly all the gas examiners of the world as a standard—notably as the Parliamentary standard of Great Britain.

The light from gas burned in the open-tip or Argand burners is produced by incandescent particles of carbon liberated from the gases and continuous spectra are always obtained, but the various groups of color are not always distributed in the same proportion and the red orange and yellow predominate. This is owing to the low flame temperature, yet the light emitting surface is large and a well diffused and pleasant though not intense light is the result.

The discovery by Dr. Auer of the principles of utilizing the heat of the gas by applying the heat flame of a Bunsen burner to a lace-like mantle of very refractory metals, immediately opened a new era in gas lighting and the gas manufacturer was appalled by the fact that by the more economical application of the heating power of the gas to a secondary medium instead of its contained carbon, over twice the candle power was obtained from much less quantity of gas.

The chemical theory and development of light in this new way is a tempting subject but out of place in a paper of this kind; hence it is enough to say that by continued research and application of skill the incandescent mantle now develops five times as much light with 40 per cent. less gas.

This discovery has cast some doubts on the methods employed to determine the lighting value of gas, and photometric standards are tottering on their base; for why should not a gas be tested and its candle power determined by the burners giving the greatest efficiency? If so, the 20 candle gas of to-day would be the 166-candle gas of to-morrow. This brings to our minds the fact that we must measure the value of gas by its heat units per cubic foot rather than its easily disputable candle power.

The illuminating effect produced by different sources of light is dependent upon three conditions: First, the surface from which light is emitted; second, the intensity of flame temperature; and, third, the color of the light emitted. If a source of light has a large area and high intensity as in incandescent gas lighting, the result is a well diffused, far-reaching light.

Diffusion of light depends on the area of the surface from which the light is emitted. This is obvious because every portion of the surface gives out rays of light which travel in straight lines, and the more surface the more rays. For instance, the portion of mantle of the incandescent gas burner which is highly incandescent, has a outside surface area of $9\frac{27}{100}$ inches per 100-candle power, or $\frac{9\,27}{10\,000}$ inch per candle. From every part of this mantle rays of light are projected in all directions, and if the mantle is highly heated it furnishes a light both brilliant and far reaching.

In contrast with these conditions, the carbon filament of a 16-candle power 110 volt incandescent electric lamp has a surface area of only $\frac{1\,2\,2\,0}{10\,000}$ of an inch, or $\frac{76}{10\,000}$ inch per candle. This light is different in color, of lower intensity, and has only $\frac{1}{76}$ the diffusing area of the outside of a Welsbach mantle and is entirely unsuited to the requirements of good street lighting.

The arc electric light, which is "nominally called 2,000 candle power," gives an amount of light when tested photometrically in the same manner as other lights, equal to about 500-candle power; but what is known as French measurement (*i. e.*, measuring the candle power from four points of the compass — $500 \times 4 = 2{,}000$) increases this to 2,000, but most gas engineers would not be surprised if the candle power of an arc lamp were multiplied by all of the 32 points of the compass in order to pad out its shortcomings. It has been estimated that in a continuous current arc lamp 5 per cent. of the total light is due to the arc, about 10 per cent. is furnished by the negative carbon, and the remainder, or about 85 per cent, by the positive carbon.

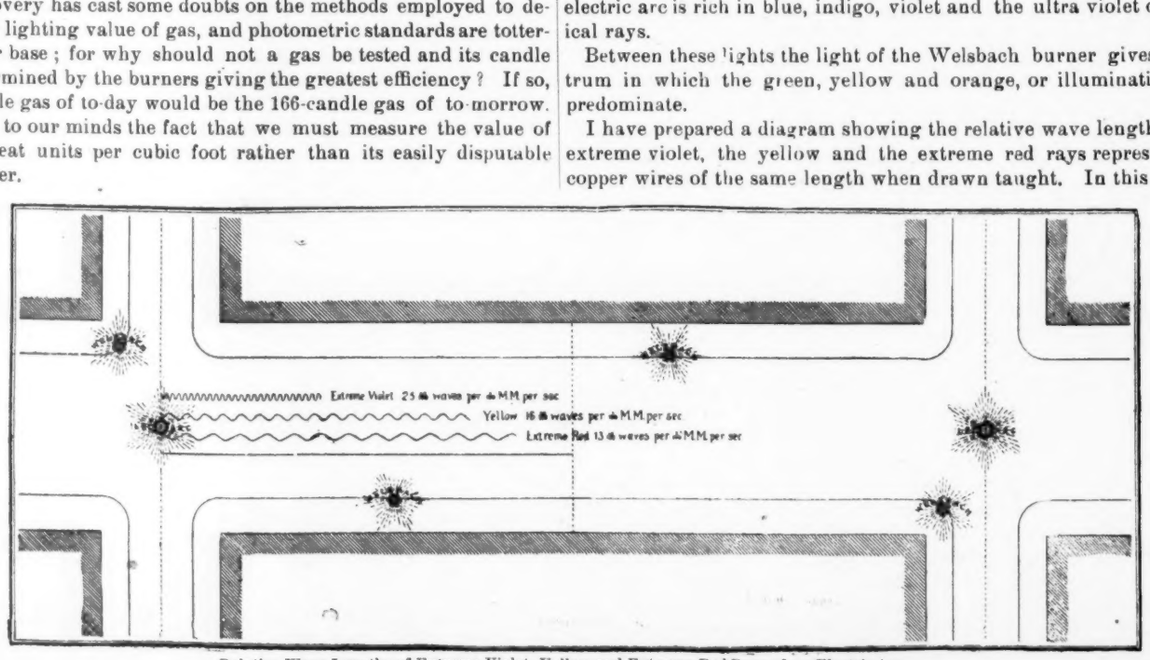
The crater of the continuous current copper coated carbons has an average area of $\frac{8\,1}{1000}$ of a square inch, and assuming the candle power to be about 500, the light emitting surface would be 42-millionths of a square inch per candle. The intensity of this light is exceedingly high, but because of its small light emitting surface, the number of rays is small and consequently the diffusion of light is imperfect. The Welsbach mantle has an area 2,207 times greater than the crater of an arc light carbon. The color of light, as well as the color of objects lighted, plays a very important part in illumination, and without treating the subject in too technical a manner, I want to call attention to easily distinguishable effects of lights of different colors.

The old-fashioned oil lamp with its red flame gave out well diffused, far reaching rays that penetrated a fog better than the blue rays of the electric arc, and for this reason the lighthouses of the world do not use the electric light and railroads use red lamps as danger signals.

In the oil flame and the ordinary gas flame, the orange and red rays and the ultra red or heat rays predominate, while the light from the electric arc is rich in blue, indigo, violet and the ultra violet or chemical rays.

Between these lights the light of the Welsbach burner gives a spectrum in which the green, yellow and orange, or illuminating rays, predominate.

I have prepared a diagram showing the relative wave lengths of the extreme violet, the yellow and the extreme red rays represented by copper wires of the same length when drawn taught. In this diagram



Relative Wave Lengths of Extreme Violet, Yellow and Extreme Red Rays of an Electric Arc.

$\frac{1}{100}$ millimeters is represented by half of a city block, and the wires are bent in waves to represent the number of waves of the different colored rays per $\frac{1}{100}$ millimeter second. These numbers of waves are for extreme violet, $25\frac{42}{100}$; for yellow, $16\frac{95}{100}$; and for extreme red, $13\frac{15}{100}$ waves.

This illustration seems exaggerated, but ordinary observation of the lighting effect of the arc light and the Welsbach burner will demonstrate its truthfulness, especially in a foggy atmosphere. You are all familiar with the sound effects of an approaching brass band. First, the low tones of long wave lengths of the bass drum reach the ear, then the bass tuba, trombones. alto horns, and cornets with sound waves of shorter lengths, until finally the music of the flutes and piccolos with their waves of rapid vibration is heard. This is sometimes imitated by pieces of music such as the Turkish Patrol, and serves to illustrate the diagram where light of different wave length takes the place of sound.

Incandescent gas lighting is rapidly and permanently displacing all other methods of street lighting in the United States, while in Great Britain and on the Continent (which is the birthplace of the Welsbach light) rapid strides have been made in this best way of lighting. In Liverpool incandescent gas lights are used on all the city streets, while clusters of two, three, four and even more are placed in one lantern on the principal thoroughfares. Some crossings, public squares and bridges have a number of lamps grouped on one post. Liverpool tried the experiment of street lighting by incandescent electric lights placed on poles of the electric street car lines, but these were soon supplanted by the incandescent gas lights. Glasgow is lighted partially by Welsbach burners and many flat-flame burners are used. In Edinburgh the streets are better lighted than in Glasgow, and many more Welsbach burners are used. Nearly all the cities on the Continent are lighted by Welsbachs. Some of the principal streets are lighted by four or more rows, the lights being placed directly opposite one another instead of diagonally as in our own cities.

This is particularly noticeable in Paris, the most beautifully lighted city in the world; wherever there is the slightest need of light a lamp is placed, apparently without thought of expense. Some of the boulevards are lighted with 4 and 6 rows of incandescent gas lamps, and the absence of electric lights is everywhere conspicuous. Standing at Place de l'Opera, a view is had of the Avenue de la Paix, lighted by incandescent gas lamps, and at the same time, without changing position, one sees the full length of a great boulevard entirely lighted by electric arcs. The opportunity for comparison could not be better, and all in favor of gas. The electric lights have dark areas between them, while the gas gives a uniform, soft light, covering the entire street surface.

During the World's Fair at Paris, the Paris Gas Company lighted the parks of the Champs de Mars with the Welsbach burners and the Trocadero with another type of burner known as the Denayrouze, to demonstrate the superiority of gas over all other illuminants for street lighting. The light of these burners aggregated 1,000,000 candles distributed over an area of 238,000 square yards with an hourly consumption of gas of 47,000 cubic feet.

Following is given the comparative cost of different lights at San Francisco prices:

A Welsbach light consuming 3 cubic feet of gas per hour gives a light equal to 100 candles, and, at $1.40 per 1,000 cubic feet, costs $\frac{42}{100}$ cent per hour, $\frac{42}{10000}$ cent per candle, or 23,809 candle hours for $1.

An ordinary gas burner consuming 5 cubic feet of 20-candle gas at the above price costs $\frac{7}{10}$ cent per hour, $\frac{35}{1000}$ cent per candle, or 2,857 candle hours for $1.

The present price of street lights is 9 cents per night for gas and 35 cents for electric arcs.

Cost of a 10-Hour Night:

Ordinary gas at 9 cents = 200-candle hours, or 22-candle hours for 1 cent.

Arc light at 35 cents = 3,000-candle hours, or 85.7 candle hours for 1 cent.

Welsbach light at 9 cents = 1,000 candle hours, or 111 candle hours for 1 cent.

The following table gives the number of inhabitants of some of the larger cities of the United States per 100-candle power of street illumination:

San Francisco...	40 inhabitants.	Buffalo.....	65 inhabitants.
Boston	44 "	New York and Brooklyn.....	86 "
Cincinnati	51 "	Baltimore.....	101 "
Chicago.....	58 "	Omaha	120 "
Cleveland.....	65 "		

The above shows that San Francisco is better lighted at present than any of these other cities.

A Century of Engineering.

[By Mr. W. A. Bole, President Engineers' Society of Western Pennsylvania.]

The present time seems to be a peculiarly fitting one to indulge in a few reflections upon what has happened during the century just completed, and particularly so on account of the very large, the predominating part, which was displayed by the mechanic and the engineer, the artisan and the scholar, in that development, whose like was never seen in equal time since "The evening and the morning were the first day."

Other centuries produced the warrior and the conqueror, whose glory was achieved at the expense of the blood of thousands. The genius of the present day, and of the cycle just completed, is a peaceful genius. He is the mechanic, with his twin brother, the engineer, the brawn and the brain, the way and the will.

The Steam Engine.—There is perhaps no one way in which the wonderful advance of the mechanical arts can be so clearly and distinctly presented to you as by calling your attention to the fact that 100 years ago the steam engine had barely been invented and applied as a means of furnishing motive power for manufacturing purposes. It is a matter of history that James Watt obtained certain patents for improvements in steam engines as early as 1781, or 19 years before the nineteenth century begun, but for a long time he seems to have been practically the only engine builder doing business, and his patents probably prevented others from entering largely into this field, until about the beginning of our nineteenth century. Contrast such state of affairs with the present times. The steam engine of to-day is the controlling feature of our industrial civilization. It furnishes the motive power by which all our manufactures are impelled, and without its use scarcely one of the articles which we use in our everyday life could be produced in sufficient quantity to satisfy the needs of mankind. It is as unnecessary as it is impossible to indicate just how deeply and to what extent this most useful machine is concerned in our comforts and business interests. Looking back to the beginning of the nineteenth century, it was at that time a "coming event," no doubt of wonderful interest to the people of that generation; but it had been seen by few and employed by still fewer of the people of that day. Their motive power was confined almost wholly to the use of water wheels, and this, of course, was a matter of geography and topography, consequently only a few favored localities were available for manufacturing purposes. Now we can locate a manufactory at almost any place we please, and other considerations than those of a century ago determine the choice of location. The steam pressure of those days was very low. Watt employed steam pressures of about 7 or 8 pounds above atmosphere. The large portion of his effective pressure, as shown by indicator diagram, was below the atmosphere line, as his engines all ran condensing. There has been during the century a gradual improvement in the art of construction, and the development of the steam engine since the days of Watt and during the century just passed has been chiefly along the line of improved details. The mechanics of that day did not have such facilities with which to construct them as we have now. The boiler pressures in current use have steadily risen during the past century as better materials and better workmanship made higher pressures safe and advisable.

To-day 125 pounds per square inch is a very common pressure for ordinary stationary engines; 150 to 175 pounds pressure is frequently met with in power plants of the better sort, and in some cases 200 pounds pressure per square inch is employed, with the suggestion that even more may shortly be called for. This, of course, enables the steam engine to yield a much larger output of power per ton of total weight, and as it has been possible to increase boiler pressures so also the working parts and the structure of steam engines have been improved and strengthened, until now the weight of engine per horse power of capacity and the cost of plant are vastly less than in Watt's time. It is interesting to conjecture how these early engines must have been built. The machine tools of to-day, such as the engine lathe, the planer, the milling machine, the radial drill, and others, did not exist then, and much of the work must have been done by hand. It is difficult to locate precisely just when the advent of machine tools in their present form took place, but it is reasonably certain that the slide rest, by which the lathe of to-day supports its tool and does its cutting, although invented by Maudsley in 1794, was not generally employed before the past century was well advanced, and the iron planing machine was not employed until about 1830. At the beginning of the nineteenth century all turning in lathes was done

by the use of hand tools, much as wood turning is still done in our pattern shops or cabinet departments.

The art of molding and the making of iron castings, while far inferior to these branches as conducted to-day, were nevertheless more nearly adequate, I imagine, than the machine shop facilities of that period. Watt's early cylinders were not more than ⅛-inch out of round in 18 inches. All this within a period of 100 years. There are few of us, I dare say, whose lives have not overlapped that of some ancestor who witnessed the advent of the nineteenth century, and such reflections may assist us in getting a clearer grasp of the extraordinary strides which have been made in the development of matters mechanical in that time. In that time the world has made more material progress, certainly more mechanical progress, than in all the preceding centuries of history.

Railroads.—The improvements in means of transportation of persons and materials during the past century mark a wonderful degree of progress, and again, in this respect, the advances of 100 years, when recalled, seem marvelous. The locomotive, by which we are drawn in ease and comfort from one extremity of a continent to another, did not exist at the opening of the nineteenth century. The first successful attempt on this line seems to have been made by Trevethick in 1804, he being the first person to successfully employ a machine which depended upon friction between its own wheels and iron rails to afford traction. The progress in railroading since that time seems like a fairy tale. The means by which our forefathers got about from place to place, previous to the beginning of the nineteenth century, was confined to animal means or to the slow and tedious canal boat, or sailing vessel, and the time employed in making trips of any length must have been very great. Stephenson brought out his famous locomotive, the "Rocket," in 1829, at a time when the century was nearly one-third passed by. Since that time there has been a great procession of mechanics, vigorously and continuously employed in improving the details, increasing the size and capacity and bettering the efficiency of the iron horse, until now we are able to make the trip from New York to San Francisco in 100 hours. When our ancestors came across the Allegheny Mountains from the eastern shores of this country some of them came by canal boat, some of them rode in stage coaches or on horseback, and it is possible that not a few of them walked. How long it took them to come it is now rather difficult to tell, but some comparison may aid us in taking in at a sweep what has transpired in this direction within a century. The introduction of the telegraph in 1843 by Morse had doubtless a great deal to do with the development of railroading, as it made communication between distant points, and the control of trains when out on the line, possible and reasonably sure.

The introduction of the air brake as an important feature in railroading took place in 1869, and this improvement made it possible to run trains at a higher speed and yet with greater degree of safety than had hitherto been known. Marking the advance of railroading during the century, mention should be made of the introduction of sleeping cars by Pullman about 1859, which has had a great deal to do with our comfort and welfare while "on the road." The progress of railroading has been marked by great and radical improvements in road bed construction, in the building of bridges and viaducts, in the employment of means for signalling, for operating switches, and in every other direction. The railroad bridge, such as we now look upon as a matter of course, was in that early age, 100 years ago, unknown. The truss bridge did not make its appearance until after the last century had gotten well on toward the halfway point. The use of the arch and of the suspension bridge in a mild way dates back a long distance, but the use of the truss, in which no stresses except vertical ones are transmitted to piers or supports, was not known.

Navigation.—We do not do all of our traveling, however, on wheels, and when we consider means of navigation we learn by the records that the first successful attempt to propel a boat of any kind by machinery was made on the Clyde in 1802. Fulton, who is generally regarded as the father of the steamboat, built his first successful boat in 1807. Her length was 130 feet, her draft 4 feet, her capacity 160 tons, her steam cylinder 24 inches in diameter, 4 feet stroke, her speed 5 miles an hour. It is a far cry from this creation of Fulton's to such a floating hotel as the "Deutschland" of to day, whose length is 684 feet, whose depth is 44 feet, whose engine power is 35,000 horse power, and whose speed when ploughing the ocean reaches almost 25 miles per hour. The intervening years have been filled in this field of labor, as in others, by persistent, intelligent and indefatigable workers, each contributing something to the sum total of good, and we who live to-day profit by their labors and honor them for their achievements.

Metallurgy.—Turning from this subject to another of equal interest to us who are here present, the metallurgical advances of the past century are fully as stupendous as those already cited. It needs little beyond the suggestion of the steam engine's status at the beginning of the nineteenth century to prove that the art of manufacturing and using the more ordinary metals, and in particular iron, was then very insignificant. Without the steam engine the blast furnace, the forge, the rolling mill, the foundry, were impossible. The manufacture of iron in those days was necessarily very limited, although they did succeed in making a little of a good many things which we still use. The manufacture of iron in our own country must have been limited largely to the bloomery or the Catalan forge, in which a wrought iron rather than a cast iron was produced. These furnaces or forges, which seem to have been a sort of compromise between a blast furnace and a puddling furnace, supplied by a blast of air obtained by various means, all which are now obsolete. Skins of animals probably enabled the old fashioned bellows to be constructed. In some favored localities the curious effect of compressing air by a falling stream of water was employed, and it is probable that in some cases piston compressors were employed, these latter impelled by water wheels. When the steam engine became available for this sort of service, it naturally gave a wonderful impetus to the manufacture of iron, since it enabled blast pressures to be increased and furnished power by which to hoist the stock, to convey away the product, and to supersede manual labor in almost every direction. It would be impossible to trace the progress of this wonderful art within the limits of the time here allowable, but a few of the important events may be cited to indicate how matters progressed from year to year. The waste gases from the tops of furnace stacks were first utilized in 1811, probably to burn in the boiler furnaces, to generate steam for the blowing engines. The use of hot blast was introduced in 1828. The steam hammer was invented by Naysmith in 1842. Previous to that time all forging had been done by hand, or by the now antiquated helve hammer, deriving its motive power from either the steam engine or the water wheel.

This is pre-eminently an age of steel, and yet Sir Henry Besse mer introduced the first practicable method of converting iron into steel, at least for structural purposes, when he brought to light his pneumatic process of conversion in 1856. That other and rivaling method of converting iron into steel—namely Siemens-Martin regenerative open hearth process—was successfully introduced about 1868. Since that time the progress in iron making and in steel making has been in the line of improvements in detail, the introduction of machinery of the most modern and substantial sort for almost every operation connected with the manufacture of iron and steel, until to day, as antitheses to the Catalan forge of 100 years ago, we have such gigantic blast furnaces as those found at Duquesne, Youngstown, Bessemer and other places too numerous too mention, whose average daily capacity reaches the enormous figure of 600 tons for a single stack. These monstrous furnaces are some 23 feet in diameter at the largest part, over 100 feet in height, and call for 45,000 to 50,000 cubic feet of free air per minute. Such a furnace under the most favorable conditions will produce a ton of iron with a consumption of 1,700 pounds of coke, under average conditions will produce a gross ton of pig iron for something better than a net ton of coke.

From the helve hammer of 100 years ago, or the first steam hammer of 58 years ago, is a long stride to the latest and most modern machinery for forging iron and steel, the best illustration of which is found in the monstrous hydraulic forging press operated by the Bethlehem Steel Company in the eastern part of our own State. This immense machine is capable of exerting a pressure of 14,000 tons upon the material placed between its dies. It is capable of receiving and successfully reducing to suitable section an ingot of steel whose cross section is upward of 6 feet in diameter and whose total weight is 275,000 pounds. Tributary to this machine is the modern method of hollow forging, by which such articles as shafts, gun hoops, gun tubes and various other shapes are produced by being forged upon a mandrel, thus increasing the compressive power, and more thoroughly working every portion of the material contained in a large shaft or similar shape. Such other accessories as mark the advances in art of iron and steel manufacture are so numerous as to defy description. Such features as hydraulic cranes, continuous rolling mills for automatic production of bars and the like, heating furnaces and improvements therein, metal mixers or reservoirs for molten iron on its way from the blast furnace to the steel plant, can only be mentioned, but not described.

Electricity.—During the past century the art of making ice by artificial means was introduced, and the first successful machine for thi

purpose is reported to have been introduced in 1855. The telephone, the telegraph, the submarine cable, the phonograph, the biograph, and all the kindred and marvelous inventions related thereto have been brought to light during the century which has just passed into history. The cylindrical printing press, the linotype, and a great many of the important features of the art preservative were brought to light since 1801, starting a new cycle of years on its way. Photography, although scarcely a matter of mechanics, nevertheless of wonderful interest and service to us now, was born during the period under discussion.

The past century produced the gas engine, that lusty young rival of the steam engine, which is now threatening to supersede the latter for many purposes and offers much promise of future development.

Electricity 100 years ago was little more than a speculation of the philosophers, and as far as being a factor in the activities of that day, it might compare with the present status of hypnotism.

To be sure Franklin had flown his kite, Galvani had observed the muscular contraction of the frog in certain connection, and frictional apparatus had enabled the savants of that day to produce sparks and other interesting effects of no present utility.

It was not until the present century had almost spent itself that electricity gained a place in engineering, but its present foothold seems to be too evident to be doubted. During the past century currents of electricity have been obtained in two ways, both unknown hitherto. The oldest of these was by chemical means, from voltaic cells or batteries, and the means is still employed by many of the lighter kinds of service, and to day it rings our door bells and summons us to our meals.

The other means of producing currents, and the one by which such wonderful impetus has been given to this particular science, was the mechanical, or the dynamo electric. In 1820 Professor Oersted of Copenhagen discovered that an electric current from a battery, passing through a wire, acted on a compass needle placed near the wire and tended to turn the needle. And in the same year it was discovered that electric currents could produce magnetism in iron and steel, and the electric magnet was born. In 1831 Faraday began the series of discoveries which form the basis of modern electric practice. He showed that a magnet could produce electric currents, and thus made possible the construction of the modern dynamo or electric generator. It was not until the latter half of the last century, however, that these principles took form in practical machines, as distinguished from laboratory apparatus, and three quarters of the century was gone before we saw the streets and buildings of our Smoky City illuminated by the arc and incandescent lamp, and only 15 years ago did the patient car horse doff his harness and acknowledge his inferiority to the now ubiquitous trolley car.

Truly so lightninglike has been the progress of this wonderful science that we are reminded of the mythologic story of the Goddess Minerva, who sprang "full armed from the brain of Jupiter" To day electric generators are busily revolving in every land under the sun, and the size and capacity of some of them stagger the understanding. In New York City are single generators producing as much as 3,500 kw. of electric energy and requiring monster engines developing as high as 6,000 indicated horse power to impel them. Even larger units are now under construction, and generators of 5,000 kw. are building to day.

Niagara is harnessed by this subtle, elusive, but persuasive fluid, and Horse Shoe Falls has superseded the mule for urban transportation, in that vicinity, has even usurped his very name, and electric current is sold in the open market as "horse power."

The battery generated current made possible the telegraph, which became a tremendous agent in the world's development, at its advent in 1843 44.

The submarine cable connecting Europe with America was laid in 1859, and I am sure some of you older members of our Society can remember the time when this now common means of communication seemed like a miracle of invention. Events of this class "have trod on each others' heels, so fast they followed." The telephone and the phonograph have come within the recollection of even the youngest member here present. Electric chemistry, electric metallurgy, electrotherapeutics, are they not all of that wonderful epoch whose close we have just witnessed? The first message ever flashed across the Atlantic cable was from the good Queen Victoria to our President Buchanan, and the words were these: "What hath God wrought?" In summing up the results of a century's progress in electrical matters, what more fitting words can be employed than these of the gentle sovereign of our mother country.

In the mechanical progress of the past century, it is fair to say that our country has contributed a very fair share and done its full quota in the matter of development. It is of course true that the mother country has been the birthplace of many of the notable events in that industrial progress, especially during the early half of the century just passed. It is but natural that American progress in these arts during the early half of the century should be relatively small as compared with the mother country. Our predecessors of the early portion of the century were engaged in fighting Indians, cutting down forests, in making highways, in tilling the soil, and in doing that amount of pioneer work which has made it possible for us, their successors, to turn our attention to the inventive arts and to rival the mother country and her European competitors. To day American supremacy in many lines of manufacture is a recognized fact, and the nations of Europe are becoming greatly alarmed at the danger which seems to impend to their interests from the active Yankee. Our superiority, if it indeed exists, should not be accepted too complacently by ourselves, nor should we flatter ourselves that we possess a capacity and an intelligence beyond that of our European competitor. Much of our progress is a matter of fortunate circumstances. We owe as much to the bountiful supply of mineral advantages which nature has prepared for us as to any personal merit of our own, and American superiority of to day in a manufacturing sense is largely attributable to these matters of good fortune which are ours. Our American export trade has increased to a tremendous amount, and it is estimated that during the last year, 1900, something over $200,000,000 worth of American products were carried across the ocean to foreign lands. This is in marked contrast to the state of affairs existing at the opening of the 19th century, when few manufactured articles were made in our own country, and when the imports vastly exceeded the exports.

It may be serviceable now to mention some of those matters in which the past century has not been so productive of progress. Architecture, as an instance, seems to me to be in marked contradistinction to matters metallurgical. There are structures of great grandeur and sublimity found throughout the older countries of the civilized world which seem to defy competition. Ecclesiastical architecture in particular seems to fill this description. The ancient cathedrals of Europe, as, for instance, St. Peter's of Rome, St. Mark's of Venice, the cathedrals at Milan, Cologne and Paris, have not been equaled by any edifice, to my knowledge, during the century just passed, and it is a matter of great wonderment how, in the early ages (now centuries gone), it was possible for men to construct some of these monuments of human skill. In other of the finer arts, as painting and sculpture, the past century has not shown any improvement upon, if, indeed, an equality with previous centuries. It may be said in justice that the latter age and the century just passed is pre-eminently an age of utility, and it is no longer considered to be as good form to spend time and effort to emulate the works of Michael Angelo as in designing and building railroad depots, apartment houses and hotels, and comfortable dwelling houses. The tendency of this change of intent has been for the good of the masses of people, for the emancipation of the lowly, and for the more complete recognition and realization of that brotherhood of mankind which is more generally recognized now than it was in the days "when knighthood was in flower."

The introduction of the art of printing was made long before the advent of the 19th century, but certainly during this century the improvements in this art, as well as the facilities for distributing the products of that art, have had a wonderful lot to do with the material advances which have taken place during this epoch. Books are now, by modern methods of printing, so cheap and so available to everyone who will read that they bring to every man for his individual improvement and assistance the records of the past achievements, and thus enable him to take advantage of all that his predecessors have done and have discovered.

In a social sense the introduction of machinery during the past century has shortened up the hours of labor for the toiler, has made his work less arduous and exhausting, has cheapened almost every article which he consumes, and has made of the serf and the plebian of a few generations ago the citizen and the individual sovereign of to-day.

In thus attempting to review the advances made within the space of 100 years, comparing such advances with what had transpired in previous ages, one is forced to the conclusion that in matters of pure intellect the representative man of to-day is not very much, if at all, superior to his compatriot of 20 centuries back. The architecture, the sculpture, the oratory, the logic of the Greek, is not surpassed by any living master of the present moment, but, as it seems to me, this intellectual capability is directed nowadays in channels very much more useful than ever before. The efforts of the man of to-day are directed

constantly, no matter in what line of occupation, to increase of capacity, betterment of efficiency, and to the saving of time. As a result, we live, in a sense, very much longer than our ancestors, and our individual experiences are perhaps as varied and as extensive as though we had lived two or three centuries instead of the allotted three score and ten years. It is a fact, however, that longevity has been increased during the past century, doubtless due to improvements in all branches of sanitary engineering, and to strides in the arts of surgery and medicine, until we are now able to "stand" off the grim reaper for a longer time than were our forefathers.

Future.—If one were to ask what is to be expected in the way of industrial progression during the century which we have now entered upon, the answer is beyond the writer's capacity to even guess. Doubtless the people of 1801 thought they were pretty well on in the arts and sciences, and it is not unlikely that any prophet of that distant year would have made a successful stagger at predicting our present status. It would seem to be equally unwise at the present time to venture upon any prediction as to what may happen between now and the year 2001. It may be said, however, that the high pressure life of to-day makes incumbent upon the man of to day a grade of application, of study and of personal mental improvement which will be emphasized and accentuated during the coming years. Improvements in mechanism necessitate improvements in mechanics as well, and the mechanics and the engineers of a century hence will have to be men capable of living up to the lights of that advanced epoch, just as the most successful men of to day are necessarily studious, vigorous and indefatigable in their labors. It may easily become the task of the retiring President of the Engineers' Society of Western Pennsylvania, in making his annual address in 2001, to refer back to the blast furnace which I have just mentioned as a mechanical marvel, and to the hydraulic forgiug press, which I have referred to, and he may consider these as evidences of man's puny attempts at dealing with materials when the subject now under discussion shall be 100 years older. Let us indulge the hope that the grandsons and the great grandsons of the engineers of 1901 may be worthy of the age and the opportunities in which they shall operate.

Education and Competition.[1]

There is nothing more difficult to write upon than education; or—in case some unkind critic might remark "obviously"—we had better say there is nothing more difficult to think rightly upon; especially if it be the education of an engineer. At the present time one thing stands defined; that the engineering education of the past will not suffice for the future. Those now prominently before the country as eminent in the profession have attained their position by natural genius, and rather in spite of, than aided by, school or college instruction. Such instances as certain eminent Cambridge graduates who have made names as engineers may, perhaps, be cited to the contrary, for the mathematical education they received doubtless formed a large part of their intellectual outfit. Still the rule applies, for though the mathematical education may have been perfect, the engineering side, by which alone the mathematics were made useful, had to be acquired elsewhere.

By way of precaution, we would say that we do not suppose a man can learn engineering as a profession, or as a calling, at schools or colleges alone. But the things he can learn, and should learn, are the natural laws which govern all engineering practice. These laws of Nature cannot be violated, they are inexorable; and all the engineer can do is to combine them so as to make his completed work, or engine, carry out its appointed function with greatest economy. At the present time a long correspondence is going on in the *Times* as to the position mathematics should hold in the education of a naval officer; and though the engineer needs somewhat different attainments from those of the executive officer in the Navy, yet the letters might be read with advantage. The great error into which teachers have fallen has been to look on mathematical studies as an end in themselves, and not as a means to an end—as a finished structure, rather than one of the tools by which structures should be created. There are many engineering problems which can hardly be solved except by the use of higher mathematics; but, however true this may be, mathematics are the lever by which the weight is raised, and not the motive power. The latter is the faculty of the engineer, to combine harmoniously all laws and all sciences involved in the solution of the problem.

Whether the country is most fortunate that has a few great engineers, or a large number simply capable, is a question upon which diverse opinions may be held; but is of considerable practical importance. On one side it will be said that the highest intellects do the originating work, and the man who originates will always have the start of those who copy. It is questionable, however, whether the rule applies with equal force to nations. Indeed, there are some very notable examples before the world just now of inventions made by Englishmen of which foreign countries have not only secured the chief gain, but have used these very inventions as weapons for fighting us in the markets of the world. The basic process of steel making will doubtless occur to many in this connection, and it is quite possible to imagine that if Thomas had never lived, or, at any rate, had not received a technical education, the American and the German steel industries might not have overtopped our own in the way they have done. Of course, if Thomas had not undertaken the task, others might have solved the problem sooner or later; but perhaps it might have been very much later; and in any case there is no certainty in speculating on the might have-beens.

There were reasons, due to the natural resources of the countries, why the basic process should have made rapid progress in Germany and the United States; but the instance may, nevertheless, be taken to illustrate the advantage to a country of a number of simply competent men. In England, Sidney Thomas, the genius, makes an invention—inaugurates a new process; a dozen competent engineers, or metallurgists, in Germany, a dozen or so more in America, put it into practical shape and make steel by it. It is, perhaps, difficult to see what great difference it would have made had Thomas been an American, or a German. Certainly it would have made a vast difference had Germany and America lacked the simply competent men.

Still, there is a difference even in the case of genius. Thomas took his invention first to his own countrymen, and it was by the aid of English steel works that he brought the basic process before the world. Had other things been equal—had the "simply competent men" and the natural resources been present—it is reasonable to suppose we should have held our lead in the steel making industry of the world.

Whatever may be the national values of the genius and the competent man respectively, it is evident that the country that has both must be the best off. In the matter of education, what is likely to produce the competent many will also develop the select few, supposing a proper sifting out be observed. But genius is rare, and, indeed, the simply competent are rare, so that the net must be spread wide to secure the talent that the country produces. It is here that Great Britain is falling behind many of her competitors, and the developments of the last 10 years emphasize this strongly. In regard to technical education—using the term in its broadest sense, and not as confined to the schools—we, in this country, have had an incalculable advantage up to within the last few years. Every engineering factory in the kingdom has been, in the past, a school for technical education of the most efficient sort. All the academies of the Continent could not alone vie with our workshops in training mechanics and mechanical engineers, and so long as we retained an overwhelming preponderance of workshops, our engineering supremacy was assured. But from small beginnings the Continental factories, and still more those of America, have worked up to establishments of large size employing vast numbers of men, and this, combined with the higher technical training abroad, has made extensive inroads into our former exclusive markets.

The change that has come over shop practice has helped our rivals. Of old the hand skill, that came only after years of training, was the prime factor in all engineering production. Every advance in machine tool construction has helped to level this distinction; the planing machine, the slide rest, and the copying lathe are familiar examples of a past generation; whilst milling practice and automatic screw machines are recent manifestations. By systems of multi-production and interchangeability, in which parts of machines are duplicated by the hundred with automatic machine tools, the old hand skill is superseded, but the demand has arisen for a large body of superior workmen who have been trained to think, to devise and scheme, to accommodate known principles to new ends, and to produce new forms. The true British workman could do what he had been brought up to do, and could do it with a deftness of touch and accuracy of perception that would have been miraculous had it not become instinctive by long training. He excelled in the subordination of nerve and muscle to a given end, but essayed nothing that needed much mental effort. It was a thing he was rather proud of than otherwise; it was no reproach to say he could not do a thing because he had never been taught how to do it; he looked down on the brain effort by which the "handy man" (the expression has received a new meaning of late) sought to compensate for lack of skill with much the

1. *Engineering*, London, England.

same contempt as the ancient French nobility were said to regard literary or artistic genius. There are few positions in which caste is stronger than in the British engineering workshop.

However, unthinking skill can never hold its own for long against brain training, and though the British mechanic is far from devoid of the mental gifts that might be developed into a fruitful course of invention, his environment has been opposed to progress in that direction. A great deal of the invention in which America is so fruitful is the work of Englishmen or men of English parentage. Probably one prominent reason for this is the greater accessibility of American engineering employers to their workpeople. An example recently came to our knowledge. An English mechanical engineer, impressed by what has been written in our own columns and elsewhere, recently sent two of his foremen abroad to "pick up ideas." The men came back but produced little result. Things went on much as before. The employer complained, not unnaturally. We happened, however, to be in a position to know the reason for this. In the works in question, as in so many English works, the men are expected to observe "a properly respectful attitude" towards their employers. If they pass one of them they touch their caps, if a superior approaches the tool at which the man is working the latter must step aside and stand in a deferential attitude. He must recognize he is in the presence of a superior order of humanity. Now, a properly respectful attitude, without inverted commas, is a very proper thing; but it is very difficult for the average British workman, who is really a very shy and very sensitive person when with his betters, to communicate ideas freely to his employer, who, perhaps, also suffers from a defect of shyness which may be manifest in curious ways. The matter may appear of small importance, but we are convinced it is not so. For the more perfect working of the industrial machine—to meet foreign competition—it is needful masters and men should act in unison, and to this end it is needful they should better understand each other.

In our latter remarks we have been thinking more of British workshops as compared with those of the United States, of which we have had some recent experience; but on the Continent, too, there is less barrier between employer and employed, so far as interchange of ideas or shop practice is concerned.

Perhaps the distinguishing feature of America is the feeling of greater equality with the working classes and their more immediate hope of advancement through merit; whilst on the Continent the superior facilities for technical education of the craftsman is his chief advantage. The Board of Education has recently issued an admirable Parliamentary Paper—a "Report on Technical and Commercial Education in East Prussia, Poland, Galicia, Silesia and Bohemia," which we cordially advise every employer of labor in this country to expend sixpence in purchasing. It contains the results of an expedition made by Mr. James Baker for the purpose of inquiring into the results achieved in the countries mentioned. Engineers may think that these distant parts of East Central Europe can have but little influence on their trade, and doubtless we have far more formidable rivals in other countries. Mr. Baker is, however, so admirable a writer, so close an observer, that his work is fully worthy of study; and, indeed, his report is of great interest, apart from its value as and object lesson. We recognize the limitations of technical education, as perhaps is apparent from what we have already said. It is not what the man learns, but what his learning makes him, that is the true standard of value; in other words, character counts for more than education, though knowledge makes character; and therefore we also recognize the need for technical education in any country that aspires to be in the van of industrial progress. It is surprising how much is being done—and, so far as we can judge by Mr. Baker's report, excellently and widely done—in the countries treated of in the report. They are spreading the net very widely, and sifting very fine. Whilst we in Great Britain, to repeat a quotation of Mr. Baker's, are "hatching mainly clerks," and "clerks also with too little command of foreign tongues," the towns and cities of these countries are establishing schools which put within the reach of all a power to become, not only craftsmen of great skill, but scientific experts in the industry they follow. The fees in the schools are exceedingly low in all the establishments visited by Mr. Baker, and everywhere there appears to be liberal provision for those who show promise, but are not in a position to pay fees at all. Thus, in the part of Poland under Prussian rule, in the town of Frankfort on Oder, there is a trade school where the fees are £4 for the half-year, and board and lodging is arranged at £2 to £3 per month. A certain number of poor students are excused a part or even all the fees if they have shown diligence and capacity; not, be it noted, if they have passed a competitive examination test. Apprentices in all handicrafts are compelled to attend the handicraft school under penalty of fine or even imprisonment, there being no fees charged to them. This, of course, is repugnant to the feelings of a freeborn Briton, and, no doubt, many of those compelled might as well stop away. Still there is the chance for the better and more diligently disposed, and the compulsory attendance puts it out of the master's power to throw obstacles in the way and select only those apprentices who will give the whole of their time to work. That is one of the great dangers of a purely voluntary system. In some cases in these districts the masters are compelled by law to see that their apprentices attend. In this school lads commence at 14 and continue until 18, attending two afternoons a week and in the evenings. The education given appears to be excellent and designed to fit the young workman for any position. At Posen, a town of 100,000 inhabitants in the same country, 1,000 lads were "learning their handicrafts artistically and scientifically."

Lodz, a town that probably few Englishmen could place on the map—it is in Russian Poland—has "immense factories which tower up in vast square masses of enormous size; factories where 10,000, 6,000 and 5,000 hands are employed—a town that is beating American cities for the swiftness of its marvellous increase." During the last 15 years "Lodz has grown from 120,000 to 400,000 inhabitants and its houses and streets from little low wooden shanty-like houses to vast stone edifices and wide, well paved and asphalted streets, with electric trams and every up-to-date arrangement." The technical schools here are in keeping with the development of the city, and, indeed, the author of the report shows how much of the increase has depended on the advance of the people.

We need not, however, multiply instances, of which there are so many in the report, and can only again recommend it to the notice of our readers. Mr. Baker is a great admirer of the Austrian system of technical education, which is thought to be superior to that of Prussia.

The Coming Exhaustion of Nature's Stores.[1]

What is the greatest task before the engineer—using the term in its broadest sense—in the century just opening? We have had his work in the 19th century well set forth in the familiar definition: Harnessing Nature's great powers for the service of Man. The engineer has made steam and electricity, winds and waters take the place of human and animal muscle. He has contrived machinery to replace the hand and the hand tool. These great tasks have belonged to the century just closed. In that which has just opened it will be the greatest task of the engineer—be he chemist, inventor or what not—to face the problem of the world's falling stocks in Nature's storehouse.

When future generations look back upon the 19th century, whose work we now regard with such pride, it is quite possible that their chief sensation will be wonder at the profligate waste that characterized the people who first made large use of the earth's stored up riches.

We shall not be far from the truth if we say that, until the 19th century, mankind was content to live off the annual produce of the earth. A trifling use was made, indeed, of the fuels and metals and minerals stored beneath the soil, but it was a mere nothing compared with the drafts which the closing years of the 19th century have made. A moment's thought will show the truth of this statement. Take our most used mineral, coal. When the 19th century began, the railways and steamships, which now make such enormous drafts on the world's coal seams, were undreamed of. The stationary steam engine had had its beginning, but its use was still so limited that it cut no figure at all in the world's coal consumption. The principal use of coal was for household fires and for the crude metallurgy of the day, and this only in countries like England, where the removal of the forest growth had caused a scarcity of wood and of its product, charcoal.

With no railways, no steamships, no factories and mills, the consumption of metals was almost as trifling as that of coal. Not until the 19th century, and indeed until the last two-thirds of that century, did mankind begin to make any appreciable drafts upon the treasures laid up in Nature's storehouses.

For the last 50 or 75 years, however, the use of these stored materials has been prodigious. Each year sees an increase in the consumption of all the things which the earth yields; and we are accustomed to point to this growth as evidence of the world's advancement in civilization. Is it not time to ask ourselves whither all this is tending? A man cast on a desert island who should fail to take account of his supplies and then plan to husband those in which scarcity threatened, would justly suffer for his improvidence. Is it not time

1. *Engineering News.*

that mankind took account of its rapidly diminishing stores of natural wealth in order that means may be provided for husbanding such as seem likely to be first exhausted.

Something in this direction has indeed already been done with respect to certain commodities in which scarcity is already impending. Investigations have been made of timber consumption, of the stocks of unmined coal, of the prospect that the supply of coal will be equal to the demands of commerce, of the growing scarcity in many species of food fishes which once swarmed in rivers and seas. There is great need, however, for more investigations of this class, and for the dissemination of more accurate information upon these subjects. The popular mind, so long educated to the profusion which 19th century commerce has created, hardly comprehends the possibility of a world famine in any article. The wonders of invention and of science have bred an abiding faith in their ability to meet all exigencies. It is not comprehended that neither the engineer nor the scientist can make something out of nothing. They can only apply old things to new uses and devise means for the more economical and effective application of natural resources.

The most important of all questions which concerns the future of the race is, of course, the problem of food. We shall not discuss here the new meaning which the ancient doctrine of Malthus is coming to have, in view of the enormous growth in population of the civilized world during the past century. What we wish to point out is that the food supply of a great part of the world has been drawn during this century from the virgin soil of North and South America. The opening of a new century finds nearly all this virgin soil now under tillage, and much of it is so exhausted of its fertility that artificial manuring is necessary to enable it to maintain its productiveness.

The chief chemical elements necessary to a fertile soil are nitrogen, potash and phosphorus. The nitrogen, we may yet be able, with the chemist's help, to secure from the atmosphere; indeed, it is now so obtained by the slow processes of plant life; but no such ready resource is available for potash and phosphorus. The old-time resource of the farmer—wood ashes—meant merely robbing the forest soil of potash to place it on the soil of the field. The onty extensive mineral deposits of potash salts in the world, we believe, are the Stassfurt mines in Germany (owned by a trust)! and the supply of potash to maintain the fertility of the world's grain fields may before the close of the century become a matter of international concern. In this connection, it may be remarked that the irrigation of arid regions and the utilization of the alkalies accumulated in their soils may assume an importancee in future years, when the soil of humid regions becomes exhausted, that is now undreamed of.

For phosphorus, even more necessary than potash to soil fertility, the farms of the world are now largely dependent upon the fossil stores accumulated by the animal life of remote geologic ages. So long as this lasts, well and good; but little is known as to the extent of these deposits, or the time for which they can be counted on to supply the world's needs.

The dependence of modern civilization upon coal has been so often pointed out that we need not enlarge upon it here. Fortunate it is that the stores of coal on this continent are so vast that they may be considered well nigh inexhaustible. On the other hand, an increased cost of coal is certain to result from the gradual exhaustion of the best and most easily worked seams. Such an increase has already been experienced in Europe and is quite certain to be a notable factor in international industrial competition, and one of constantly increasing importance as the century advances. In the United States the same influences will be felt, but to a lesser degree. With the increased cost of coal will come an increased use of other natural forces to develop power. The closing decade of the 19th century, indeed, has witnessed a return to the use of water power (due to other causes than increased cost of coal); and the present century will see, we may be sure, much much greater applications of this natural agent, and also of the forces of the tides, the waves and the winds. It is not unlikely, for example, that before the close of the present century, sailing ships will displace steam vessels for a large part of the ocean freight traffic.

We may thus economize in the use of coal to generate power; but when heat is desired, nothing but fuel will serve. Those choicest fuels in Nature's laboratory, natural gas and petroleum, will be exhausted long before the stock of coal is appreciably diminished. In fact, there is no better illustration of the world's improvidence in its use of Nature's choicest gifts than the waste of petroleum and natural gas which has taken place in the century just closed. Had the stores of natural gas in the Pennsylvania, Ohio and Indiana fields been strictly preserved and used only for such purposes as glass and pottery manufacture, the supply might have been made to last for a century or more, and would have been an enormous boon to the world at large, and a source of incalculable wealth and prosperity to these States. Instead, this new and wonderful fuel was wasted as prodigally as if the supply were inexhaustible, and it was used in a hundred ways where coal had served and would have served practically as well. The result, of course, was the rapid exhaustion of the supply; and its practical disappearance as a factor in modern industry will probably take place in little more than a quarter century from its first extensive utilization.

The world's supply of petroleum will last for a much longer time before ultimate exhaustion occurs; yet the time cannot be far distant when increased demand and diminished production will cause an increased price. Men will look back in future years and wonder at the folly of a generation which burned and wasted so prodigally this choice gift of Nature. If an autocratic ruler of the human race could forbid its use from this time forward, except in those arts where its use is vastly important, and its loss would be a world calamity, such a decree would work great benefit to future generations and little injury to those living at the present day.

Much more might be said concerning the great economic and industrial changes which will result during the present century from increasing scarcity of mineral fuels, but space permits only a reference to the probability that such low grade fuels as lignite and peat, now of little commercial importance, will probably acquire great value as substitutes for coal before the close of the century.

Turning now to metal productions, the most useful metal, iron, is fortunately so widely distributed that a serious and world wide scarcity seems now too far in the future to be foreseen. On the other hand, long before this century is closed, the richest and most accessible ore deposits will probably be exhausted; and resort will be made to the far more extensive deposits of low grade ores. The greater cost of reducing these, in combination with the increased cost of fuel will probably make iron more costly during the present century than it is now at its opening. Actual scarcity in this most valuable of metals, however, cannot be foreseen.

Of other industrial metals, tin is the one which seems likely to be soonest exhausted, the deposits of this metal rich enough to work being exceedingly few. Copper, which is of much greater importance in the arts, stands in much the same position as iron. The high grade deposits, such as those of Michigan, Montana and Chili, will probably be worked out long before the present century has closed; but there are deposits of lower grade ore much more widely distributed, which, with improved processes of reduction, may, it is to be hoped, maintain the world's supply with no great increase in price for an indefinite period. The supply of copper will be conserved, moreover, through the fact that its corrosion loss is far less than that of iron, so that the annual loss from the world's stock by use is far less.

Zinc and lead will probably experience an increase in price as the most available deposits are worked out; but this increase will cut off a large part of their use. Before the century's close, aluminum, the raw material for which is practically unlimited in amount, will probably be largely substituted not only for tin and copper, as has, indeed, already happened, but for lead and zinc as well. In fact, it is doubtful whether any chemical discovery of the past century will prove of greater importance to the future welfare of mankind than the development of cheap processes of aluminum production.

Among the rare metals, mercury and platinum are the two which are likely to be soonest exhausted. The usefulness of these two metals, especially in the chemical industries, is so great that their loss would be a calamity, especially as in many places no known substance could serve as a substitute. The workable deposits of these metals, especially of platinum, are exceedingly few; and no important discoveries of new deposits have for many years been made.

Upon the much disputed question as to the ability of the world's gold deposits to supply the rapidly increasing demands of commerce and industry, we cannot now enter at length. It can only be said that if alluvial sands had remained the sole source of supply, the world would ere this have had to face the fact that its standard of values was itself rapidly appreciating in value through the inexorable law of supply and demand.

The development of cheap processes of mining and milling gold ores, with such chemical methods of extraction as chlorination and the cyanide process, have enormously increased the world's gold production in the closing decade of the 19th century. If this production can be maintained (and this can be done so long as low grade ores exist or can be found of sufficient extent), the supply of gold is insured which

the expanding commerce of the world demands, in order that the value of its standard shall remain constant. When this supply fails, the question of the metallic standard of values will doubtless have to be opened anew.

[To be Concluded.]

Desirability of Using Storage Batteries in Medium Size Stations.

In a paper on the subject named in the heading, which was read by Mr. L. G. White at a meeting of the Ohio Electric Light Association, the author said:

The idea seems to be quite prevalent among central station men that the storage battery is useful only for the purpose of storing energy, generating it during light load periods and storing it until such time as it may be used to the best advantage.

The storage battery is indeed a very valuable addition to any direct current station for this purpose alone, but I shall endeavor to point out to you some other features of the storage system which I think are as fully important to the medium size station as the one before mentioned.

One of the most valuable features of the storage system is its ability to maintain an even pressure on the bus bars, to which it may be connected. Even though the load may vary greatly, and the demands may be very sudden, such as are occasioned by the starting of direct connected electric elevators and other heavy motor work, the battery will maintain a fairly even pressure at the bus bars of the station. It does this automatically and without any effort whatever on the part of the switchboard attendant.

The question of regulation has been a serious one to central station managers and is becoming more serious every day.

A few years ago the public would accept a very unsteady incandescent light, possibly attributing its unsteadiness to the belief that electricity was then in its infancy, but now, possibly thinking that the infant has had ample time to mature, they demand a bright, steady light with uninterrupted service.

It is possible that the extensive adoption of the Welsbach gas lamp, giving a very steady light though it be of a ghastly color, has had the effect of making the public more critical in the matter of electric lighting; but, whatever the cause, the fact remains that your customers demand a steady light, which means good regulation, and I think most station managers are now striving to attain that end.

I have charts taken from our recording volt meters. These charts show the pressures at one of our heaviest centers of distribution They are not selected speciments, but show the actual conditions covering four months; two months with the battery on the line and two months without the battery. I would remark that most of the sharp changes in the pressure were caused by a number of large passenger elevators which are connected quite close to the center of distribution, to which these volt meters are connected. So these variations of pressure were not quite so pronounced over the balance of the system as it was at this particular point.

I think that the medium size station will find this one feature of the storage system fully as important to them, if not more so, than the feature usually considered by the larger stations, that is, the ability of the battery to carry enormous peak loads of comparatively short duration.

The larger stations with their large direct connected units do not experience the difficulties encountered by the smaller stations in the matter of regulation, but even they find it convenient to depend largely on the battery for regulation.

The incandescent lamp manufacturers have brought their lamps to such a point that there is but little left to be desired in the way of efficient lamps, but, in order to get good results from these high efficiency lamps it is necessary to have really good regulation. The better the regulation the better the results from the use of the high efficiency lamps.

Another feature of the storage system, which should appeal strongly to the medium size station, is that it affords a reliable reserve in case of an accident to your generating apparatus. Should an engine break down or a dynamo become disabled, the battery is usually ready to take up the load without any interruption to the service, and will usually carry it until some provision can be made to relieve it, thus saving an "out," the one thing of all others most dreaded by the station managers.

Another way in which the battery has proven itself useful and has made a direct saving of fuel and labor, is by taking care of the loads thrown on the station by sudden storms which are so prevalent in this part of the country during the summer months. Before the battery was installed it was common practice to run more boiler capacity than would have been required had it not been for the sudden jumps in the load caused by a passing thunder cloud, and even then it was frequently necessary to get in another boiler in short order, using boxes, barrels or anything that will make steam quickly, and then, perhaps, after only a few minutes' use, have to let the boiler cool off again, thus losing a large per cent. of the heat units stored in that boiler.

With the aid of the battery we are able to run both the boilers and engines in the most economical manner, thus making a saving which amounts to considerable in a year's run, and yet the saving is of such a nature that it is difficult to reduce it to dollars and cents, consequently the battery may not get all the credit due it from this source.

During the heavy winter load we find the battery very convenient in keeping up the pressure at the ends of the longer feeders. We connect such feeders as require boosting to an auxiliary bus and then connect the battery to the auxiliary, and by means of one of the end cell switches we can raise the pressure on these feeders as high as may be necessary.

Usually that part of the load which requires boosting is so small that we would get very poor efficiency if we were to use a pair of dynamos for this purpose, but, however, should the load on these feeders be heavy enough to warrant it, we would cut in a pair of machines on the auxiliary bus to supply the load and charge the battery with whatever capacity was left in that pair of machines, so you see we would get an economical load for the machines under all conditions.

A short circuit on heavy lines, especially if they are underground, usually means trouble for the station man and it is not an uncommon thing to have machines reversed in this manner; this of course means a shut down while fresh machines are started to repolarize the reversed machines or to burn off the short circuit. This sometimes requires a number of machines and always takes an appreciable length of time, during which your customers are saying pleasant things about electric lighting in general and about your company in particular, or perhaps are making a frantic effort to inform you by telephone that there is something wrong with their lights. We have had our usual number of short circuits since the battery was installed, but not in a single instance has the operation of the plant been affected in the least. In fact, the switchboard attendant usually learns of this kind of trouble first, from some one of the outside men. We have burned some very heavy copper and the only indication at the station has been a drop of pressure shown by the recording voltmeters and that only for an instant.

The cost of maintenance of the battery, which consists of 150 cells of chloride accumulators, has been only a very small amount in our case; the entire expense is represented by about five hours' labor per week, and about 200 gallons of distilled water per week. The water we distill in a home made still and it costs but very little indeed. The labor is applied in reading the voltage and specific gravity of each cell about three times per week and refilling the cells with distilled water, besides keeping the battery room clean. I presume that sooner or later we will have to begin making repairs on the battery, but now after one year's constant use the plates show no evidence of deterioration.

Are Municipal Electric Lighting Plants Profitable?

By Mr. M. J. Francisc.

I have read several articles regarding the success of the municipal plant at South Norwalk, Conn. After an examination of their last report, just published for the year ending October 12, 1900, I am unable to discover where the success of this enterprise is concealed. Perhaps you can give us more light upon the subject. By reference to page 11 of their report you will find the following statement: Repairs, $494.41; running expenses, $7,408.73; salaries, $5,120.51, making a total of $13,023.65 for operating. It is claimed that $209.43 was for operating the fire alarm, leaving $12,814.22 for electric plant. On the sixth page they give the inventory of plant at $62,829.49. Interest upon this at 4 per cent. would give $2,513.17. Depreciation at 5 per cent. on $57,500, as made by the light committee, is $2,875. Taxes and water rent, at 1 per cent. upon $28,500, one half of the amount upon which they calculate depreciation, is $285.

On page 6 they state that there are $42,500 in 4 per cent. bonds outstanding. A sinking fund to pay these bonds would require $2,125

per year, making a total of $20,612 39. Deducting $10,261.98 for all income from commercial and private lights and power, including $521.19 for lighting city buildings, as given on page 13 of report, and we have a balance of $10,350 41 cost to the taxpayers for 100 arc lights of 1,400-candle power burned from dusk until 1.30 A M., 312 nights per year, making, as they claim, 1,915 hours per year, being $103.50 per lamp, and costing .054 cent per hour, furnishing 259 candle power hour for 1 cent. The candle power of lamps and hours burned are shown on the 14th page of the report. The average cost of lights when furnished by private companies on contract is .0264 cent per hour, with 750-candle power per hour furnished for 1 cent.

With the facts disclosed in this report I am unable to discover where the taxpayers of South Norwalk receive the benefit claimed by municipal ownership. There is one point noticed on page 11 of report where interest for the year is calculated at $1,700. As they say upon the 6th page that the investment is $62,829.49, and that they are paying 4 per cent, I am unable to figure the interest and make it $1,700. The only result I can obtain in calculating 4 per cent. on $62,829.49 is $2,513.17.

In their report nothing is allowed for taxes or water rent, neither is any provision made for the payment of outstanding bonds. These bonds will have to be paid and a certain amount should be set aside each year for this purpose. This item is certainly a part of the expense of lights and should be included the same as the wages of employees. Another feature of the business is peculiar. As shown by the lighting committee's report for year ending October, 1899, page 11, repairs, running expenses and salaries were $7,480.30, while the report for year ending October, 1900, page 11, discloses the fact that repairs, running expenses and salaries were $12,023.65, being an increase of $4,543.35 during the year. A statement is made on the 14th page that only one additional light for streets was added during the year. When we add the operating expenses and fixed charges together and deduct the entire income from power, commercial and private lights, the balance is the amount the street lights are costing; and theorizing does not change the fact.

Can you, after an examination of their report, discover any indications, showing a profit or any advantages gained by the taxpayers in operating the municipal plant at South Norwalk?

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

WE were in error in our statement last week to the effect that the proprietors of the Gas and Electric Company, of Bergen County, N.J., were applicants for a franchise to supply gas in the New Jersey districts of Dover, Port Oram and Rockaway. While some of the peolpe interested in the Bergen County Company are also interested in the Dover proposition, it is a regrettable fact that the Company as a whole is not concerned.

MESSRS GALLAGHER & WEBBER, of Ionia, Mich., have formally accepted the terms of the gas franchise recently awarded them by the authorities of Traverse City, Mich. Construction work will be commenced early this spring.

MR. T. F. HENTZ, of Brooklyn, N. Y., is informed that Mr. Charles Taff, of Cincinnati, Ohio, was elected to the vacancy in the Board of Directors of the Cleveland (Ohio) Gas Light and Coke Company caused by the death of Col. Fenton.

THE proprietors of the Newton and Watertown (Mass.) Gas Light Company, on the 1st inst commenced a day service of electrical currents.

MR. CHARLES H. NETTLETON, President of the New Haven (Conn.) Gas Light Company, has notified the Derby (Conn.) Board of Trade that he can no longer serve as its President.

WE understand that Mr. C. H. Hammett, of Kansas City, has perfected arrangements under which the gas and electric lighting interests of Independence, Mo., are to be consolidated.

THE proprietors of the Redlands (Cal.) Gas Company have put a mortgage on that property amounting to $50,000, the San Francisco Trust Company being the Trustee. It is proposed to enlarge the plant.

MR. RICHARD S. BERLIN has been appointed official gas inspector for Omaha, Neb., vice the late Mr. James A. Gilbert.

CAPT. JOHN S. DAVITT, for many years prominently identified with the interests of the McKeesport (Pa.) Gas Company, died at his home in McKeesport the morning of January 27th. Deceased was born in Pittsburg, Pa., in 1845, and had been a resident of McKeesport since 1865.

THE General Assembly of Connecticut has been petitioned to grant incorporation papers to the Ledyard Gas and Electric Company.

AT the annual meeting of the Bowling Green (Ky.) Gas Company, the following officers were elected: Directors, J. O. Troup, J. G. Hickox, J. P. Degnan, J. K. Pelton and J. C. Lincoln; President, J. T. Linn; Vice President, J. O. Troup; Secretary and Treasurer, J. K. Pelton.

MR. J. A. MACFADDEN, of Carlyle, representing certain capitalists of Toronto, Can., is negotiating for the purchase of the properties of the Stratford (Can.) Gas Company.

AT the annual meeting of the Bellingham Bay Gas Company, of Fairhaven, Wash., it was determined to expend $30,000 in plant improvement this season. In the planning a new holder has been arranged for. The officers elected were: Directors, Nelson Bennett, E. S. McCord, Hugh Eldridge, J. R. Dawson a d W. S. Wharton; President, E. S. McCord; Vice President, Hugh Eldridge; Secretary, J. B. Dawson; Treasurer and Superintendent, W. S. Wharton.

MR. JOHN NETH, for several years in the service of the United Gas Improvement Company, at Waterbury, Conn., has been appointed General Superintendent of the Norwich (Conn.) Gas and Electric Company.

MR. S. F. HAYWARD, of the Connelly Iron Sponge and Governor Company, informs us that the headquarters of the Company have been removed from 357 Canal street to 395 Broadway. His telephone address is 3,033, Franklin.

AT the annual meeting of the Washington (D. C.) Gas Company, the Directors elected were: John R. McLean, John C. Bullitt, Jas. C. W. Orme, George T. Dunlap and R. H. Gouldsborough.

THE American Bridge Company has received the contract from the Pittsburg & Lake Erie Railroad for the new steel bridge over the Monongahela river, at Homestead, Pa.

MR. M. BRITSCH has been appointed Superintendent of the station of the Peoples Gas Light and Coke Company, located at the corner of 24th place and South Canal street, Chicago.

A CORRESPONDENT incloses the following from Wilmington, Del., under date of February 2d: "The master plumbers of this city are agitating the appointment of a gas inspector. At the request of the Plumbers' Association, Representative Robertson will introduce a bill providing for the appointment of a gas inspector. Representative Robertson, by request of the National Association of Steam Engineers, also will introduce an act for the protection of life and property against loss or damage from the operation of steam boilers or steam engines, or steam wherever used for power by incompetent persons. Similar acts are to be introduced in the Legislatures of other States of the Union. The bill provides for the appointment by the Governor of an examiner or examiners of steam engineers of the State. Each examiner or examiners shall be appointed for a tenure of 4 years at a salary of $900 a year. The object of the bill is to provide that 6 months after the passage of the act none but licensed engineers shall be permitted to operate steam engines in cities or towns of more than 25,000 inhabitants. It also prescribes a system of examinations and the issuance of certificates for persons desiring to qualify as engineers. None but citizens of the United States shall be licensed as engineers. The act will not apply to railroad and steamboat engineers."

MR. CHARLES WATSON, who was Secretary of the Camden (N. J.) Gas Company, many years, and who has acted as General Manager of the South Jersey Gas, Electric and Traction Company since the absorption of the former by the latter some time ago, resigned that post on the 2d inst. Mr. Watson retains his interest in the Company, and continues as a Director thereof.

WE understand that Messrs. Baxter & Young, of Detroit, have bought the franchises and property of the Bucyrus (Ohio) Gas Light

and Fuel Company. They will make important improvements on the works, and will greatly extend the main system.

ADVICES from Cincinnati, dated the 2d inst., says that the $100,000 bond submitted by Mr. Bradford Shinkle in behalf of the Covington (Ky.) Gas Light Company, as a guarantee of good faith in its contract with the city of Covington to furnish light thereto and therein for a period of 20 years, at the rate of $1 per 1,000 cubic feet, has been accepted by the Board of Aldermen.

A BILL proposed before the Massachusetts State Legislature specifies that "any company, copartnership or person supplying water, steam, heat, light, power, gas, oil or electricity, above, upon, in, under or through any street or highway," shall pay an annual excise tax of 1 per cent. of its gross receipts, if its annual dividends aggregate 6 per cent.

AT the annual meeting of the San Francisco Gas and Electric Company the Directors chosen were: Joseph B. Crockett, Peter Donahue, Adam Grant, Rudolph Spreckels, J. Downey Harvey, Daniel T. Murphy, Geo. W. Prescott, Albert H. Payson, Levi Strauss, Thomas B. Bishop and C. O. Hooker.

MR. C. R. COLLINS, acting in conjunction with Mr. Chas. B. Hurley, of Tacoma, Wash., has purchased a controlling interest in the Skagway electric lighting plant, heretofore operated by the Alaska Light and Power Company.

AT the annual meeting of the Coldwater (Mich.) Gas Light and Fuel Company the reports proved that the sales of gas had exceeded those of any previous year by a good, round percentage. The officers chosen were: Directors, B. H. Calkins, F. W. Moore, H. C. Loveridge, L. E. Rose, L. M. Wing, A. S. Upson and Geo. C. Turner; President, B. H. Calkins; Vice-President, H. C. Loveridge; Secretary, George C. Turner; Treasurer, F. W. Moore.

THE officers of the Dover, Rockaway and Port Oram Gas Company, of Dover, N. J., are: Directors, Addison Ely, Sr. and Jr., of Rutherford; F. Cook, of Passaic; W. H. Castles, of Kingsland; and J. H. Simpson, Geo. Pierson, M.V. B. Searing, G. O. Cummins, D. R. Hummer, J. V. Baker, F. V. Wolfe, J. W. Baker and L. R. Bierwirth, of Dover; President, Addison Ely; Vice-President, George Pierson; Treasurer, J. H. Simpson; Secretary, F. V. Wolfe.

THERE has been quite some rowing over the quality of the gas that is being furnished in Lynchburg, Va., by the Lynchburg Gas Company, the growlers being a few of Lynchburg's "first citizens"—all white. The malcontents were powerful enough to have their plaints officially considered by the Council Committee on Lights, and the Committee has determined to await the making of a final report until the City Electrician has made "thorough tests of the illuminating quality of the gas supplied!" The Committee shows its delicate judgment in naming an electrician to estimate the illuminating value of the gas supplied. Why not carry the thing further and employ a veterinary surgeon to analyze the coal which the horses drew to the various furnace rooms under the city's immediate control?

THE plant and franchises of the Petersburg (Va.) Gas Light Company have been purchased by a Philadelphia syndicate, the active man in which is Mr. F. H. Shelton. The new owners will enlarge the plant, extend the main system, reduce the selling rates materially and abolish meter rentals. The officers of the Company are: Directors, F. H. Shelton, Frank Battles, C. J. Lippman, J. D. Horsley, R. D. Apperson and R. D. McCue; President, R. D. Apperson; Secretary, Treasurer and Superintendent, Wm. H. Baxter; Manager, R. D. McCue.

AT an adjourned meeting of the Directors of the Consumers Gas Company, of Toronto, Canada, Mr. G. R. R. Cockburn was chosen Vice-President, to succeed the Hon. Sir Frank Smith, deceased, and Mr. E. B. Osler was elected to the vacancy in the Board of Directors.

THE people of Guthrie, Oklahoma Territory, are anxious that a gas works shall be constructed there. At the same time the anxious ones are disposed to grant the franchise only on terms sufficiently onerous to keep foreign capitalists from bidding.

THE South Bend (Ind.) Gas and Fuel Company has arranged with Mr. Walter Schneider, a local architect, for the construction of a new, handsome and commodious office building.

AT the annual meeting of the Manchester (N. H.) Gas Light Company, the following officers were elected: Directors, G. Byron Chandler, W. M. Parker, N. P. Hunt, W. B. Stearns and G. H. Chandler; President, G. Chandler; Treasurer, W. M. Parker; Clerk, N. I. P. Hunt.

MR. HORACE E. DUNKLE has resigned from the service of the Jamaica Plain (Mass.) Gas Light Company, to engage on his own account in the insurance business.

THE new gas rates at Newburgh, N. Y. ($1.60 per 1,000 on illuminating account and $1.10 for fuel use) have stimulated inquiries for meters that please the new management very much.

WE are informed that the Akron (Ohio) Gas Company is furnishing renewals of mantles without charge to the consumer.

A CORRESPONDENT in Boston forwards the following under date of the 4th inst.: "A feature of the recent annual meeting of the shareholders in the Charlestown (Mass.) Gas and Electric Company was the reading of a cablegram from the President of the Company (Mr. Jas. F. Hunnewell), whose greetings were dated from Alexandria, Egypt. The officers elected were: Directors, Jas. F. Hunnewell, James A. Sawtelle, Charles F. Byam, John Turner, Chas. R Lawrence, Chas. F. Fairbanks and George N. Swallow; President, J. F. Hunnewell; Vice-President, Chas. R. Lawrence; Clerk and Treasurer, George B. Neal.

MR. H. L. DOHERTY, Acting President of the Denver (Col.) Gas and Electric Company, has submitted the following propositions to the authorities respecting the public lighting of that city:

"To the Honorable Mayor and City Council of the City of Denver: Gentlemen—We understand your honorable body is desirous of making a contract for city lighting, and beg to submit the following proposition:

"We will contract to supply, for the purpose of lighting the city of Denver for a period of 1, 3, 5 or 10 years, as the Council may elect, 1,000 arc lights of nominal 2,000-candle power, measured according to the rules of the National Electric Light Association, and supply current for the same during said term or terms, the same to be burned each and every night upon an all night schedule, at and for the price of $60 per year, at such street intersections as the City Council may direct.

"We will also contract to supply arc lamps of the same character and current for the same for the sum of $60 per year each at such other street intersections as the city may from time to time hereafter order in excess of 1,000.

"In addition to the foregoing offer to furnish lights to the city of Denver, we will, if this offer is accepted, so amend our rates that the average of our charges to private consumers shall be less than 10 cents per kilowatt hour for incandescent lighting, and less than 4 cents per kilowatt hour for current for power purposes, and that the charge for arc lighting on the basis of 2,000 candle power arc lamps shall be not to exceed $8 per lamp per month furnished until 10 o'clock, and $8.90 per month per lamp furnished until 12 o'clock, and $12 50 per month per lamp furnished all night.

"We will furnish to the city of Denver a bond payable to it with surety, to be approved by the Mayor in the penal sum of $25,000 conditional that we will save and keep harmless the city of Denver from any and all damage for personal and other injuries that may occur either to private individuals or corporations, as well as to the city of Denver, resulting from or growing out of any negligence or want of care on our part in the operation, repairing or maintenance of our plant.

"The foregoing offer shall remain open for acceptance by the city of Denver for the period of 30 days, and as evidence of our good faith in making the same we inclose herewith our certified check payable to the order of the city treasurer for $10,000 and agree that the same shall be retained by the Mayor of the city for said 30 days and be forfeited to the city of Denver in the event that the foregoing offer is accepted by the city within such time, and if we fail, neglect or refuse to enter into said contract in accordance with the offer above made.

"If this proposition is accepted it will mean a saving to the city of $30,000 per annum or it will mean that the city can have 1,500 arc lamps for the same price which she would otherwise pay for 1,000 arc lamps. If the proposition as made does not entirely meet with your approval, we shall be glad to endeavor to meet your views by any such change as you may suggest."

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,
EDITORS.

CHAS. E. SANDERSON,
MANAGER.

PUBLISHED ON EACH MONDAY OF THE YEAR AT
No. 32 Pine Street, New York.

MONDAY, FEBRUARY 11, 1901.

The Market for Gas Securities.

The conditions governing the recent trading in city gas shares are quite like those that have prevailed since the first of the year, in that all floating lots in the various companies seem to have been absorbed. Quite an independent interest exists in Standard gas, particularly in respect of its common stock, and not a few shares of Mutual are still recalcitrant. The face conditions are a dull and strong market, with a wonderfully speedy absorption of any Consolidated that is offered for genuine transfer. The closing prices in the latter to-day were: 192¾ bid; offered at 193¼. All city gas bonds are in good demand.

Brooklyn Union is steadily held, which is not to be wondered at, remembering that, at 180, the interest return thereon is not very far from 4½ per cent. The Bay State Gas Company, of New Jersey, has been taken out of the hands of the temporary receiver, whereupon Bay State, of Delaware, advanced smartly "one sixteenth." Baltimore Consolidated shows no change from last week. The general list is steady to strong, especially Peoples, of Chicago.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

FEBRUARY 11.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$54,595,200	100	192¾	193¼
Central Union, Bonds, 5's.	3,000,000	1,000	108½	109½
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	120	..
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	295	299
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co. .. Bonds, 5's	11,000,000	1,000	109¼	110
Northern Union, Bonds, 5's.	1,250,000	1,000	104	104¼
New York and East River .. Bonds 1st 5's	3,500,000	1,000	106	106⅝
" 1st Con. 5's	1,500,000	..	115	.
Richmond Co., S. I.	348,650	50	70	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	130	132
Preferred	5,000,000	100	148	150
Bonds, 1st Mortgage, 5's	1,500,000	1,000	110	114
Yonkers	299,650	500	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	178	180
" " Bonds (5's)	15 000,000	1,000	118	119
Bay State	50,000,000	50	⅜	1
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works, ..	450,000	100	28	35
" 1st Mtg. 5's	503,000	1,000	96½	99½
Boston United Gas Co.— 1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
" " Bonds, 5's	5,250,000	1,000	68	71
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Central San Francisco	2,000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati G. & C. Co.	8,500,000	100	194	198
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	106	107
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	60	65
Preferred	3,026,500	100	84	86
Consumers, Jersey City Bonds	600,000	1,000	102	103
Consumers, Toronto	1,700,000	50	215	216
Consolidated, Baltimore	11,000,000	100	58½	59
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's.	1,000,000	..	..	..
Equitable, 1st 6's.	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	12	16
" Con. Mtg. 5's	380,000	1,000	80	85
Consolidated G. & E. Co.'s., Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co	4,560,000	50	88	89
" Prior Lien 5's	4,737,000	1,000	99½	100
Detroit Gas Co., 5's	381,000	1,000	100	101
" Inc. 5's	16,000	100	94	94½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	35	40
Fort Wayne	2,000,000	..	35	41
" Bonds	2,000,000	..	60	64
Grand Rapids Gas Lt. Co..	1,000,000	50	103	105
" 1st Mtg. 5's	1,225,000	1,000	..	..
Hartford	750,000	25	240	250
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	45	50
" Bonds, 6's	2 650,000	..	92	95
Jackson Gas Co	250,000	50	70	75
" 1st Mtg. 5's	265,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	86
Bonds, 1st 5's	3,822,000	1,000	101½	103
Laclede, St. Louis	8,271,000	100	73½	75
Preferred	2,500,000	100	95	100
Bonds	10,000,000	1,000	108½	109
Lafayette Gas Co., Ind.	1,000,000	100	40	50
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	110	120
Madison Gas & Elec. Co.	400,000	100	62	65
" 1st Mtg. 6's	350,000	1,000	102½	108
" 6 per cent. scrip, due 1901	100,000	25	87	89
Montreal, Canada	2,000,000	100	183	184¾
Newark, N. J., Con. Gas Co	6,000,000	..	..	55
Bonds, 6's	4,600,000	..	..	103
New Haven	1,000,000	25	280	300
Nashville Gas Lt. Co.	1,000,000	50	110	..
Oakland, Cal.	2,000,000	..	46	47
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	101½	101⅝
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
2d "	2,500,000	1,000	104	105
Rochester Gas & Elec. Co..	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	47¼	47½
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgage 6's.	650,000	1,000	82	85
Extension, 6's	600,000	1,000	..	..
General Mortgage, 5's.	2,465,000	1,000	88	90½
St. Joseph Gas Co	1,000,000	100	35	40
" 1st Mtg. 5's	750,000	1,000	96½	98
Syracuse, N. Y.	1,750,000	100	13¼	14
Bonds	1,612 000	1,000	88¼	93
Washington, D. C	2,600,000	20	307½	312½
First mortgage 6's	600,000	..	..	..
Western, Milwaukee	4,000,000	100	94¾	95½
Bonds, 5's	3,830,500	..	106½	107½
Wilmington, Del.	600,000	50	200	201

Advertisers' Index.

GAS ENGINEERS. Page

Wm. Henry White, New York City ... 235
Fred. Bredel, Milwaukee, Wis ... 222
Geo. R. Rowland, New York City ... 231
The Western Gas Construction Co., Fort Wayne, Ind ... 240
Humphreys & Glasgow, New York City ... 231
American Gas Co., Phila., Pa ... 222
David Leavitt Hough, New York City ... 222
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 219
Baxter & Young, Detroit, Mich ... 232
United Gas Improvement Co., Phila., Pa ... 227
James T. Lynn, Detroit, Mich ... 232
A. E. Boardman, Brevard, N. C ... 232
The Jeffrey Manufacturing Co., Columbus, O ... 237

GAS WORKS APPARATUS AND CONSTRUCTION.

Continental Iron Works, Brooklyn, N. Y ... 234
Deily & Fowler, Phila., Pa ... 236
Kerr Murray Mfg. Co., Fort Wayne, Ind ... 232
Stacey Mfg. Co., Cincinnati, Ohio ... 235
Bartlett, Hayward & Co., Baltimore, Md ... 233
Davis and Farnum Mfg. Co., Waltham, Mass ... 232
R. D. Wood & Co., Phila., Pa ... 234
Isbell-Porter Company, New York City ... 234
Fred. Bredel, Milwaukee, Wis ... 222
United Gas Improvement Co., Phila., Pa ... 227
National Gas and Water Co., Chicago, Ills ... 229
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 219
The Western Gas Construction Co., Fort Wayne, Ind ... 240
Humphreys & Glasgow, New York City ... 233
American Gas Co., Phila., Pa ... 222
Logan Iron Works, Brooklyn, N. Y ... 236
Riter-Conley Mfg. Co., Pittsburgh, Pa ... 235
Baxter & Young, Detroit, Mich ... 232
American Bridge Co., New York City ... 218
G. Shepard Page's Sons, New York City ... 232
James T. Lynn, Detroit, Mich ... 232
A. E. Boardman, Brevard, N. C ... 232
Sutherland Construction & Improvement Co., N.Y. City 219
Christopher Cunningham, Brooklyn, N. Y ... 234
The Jeffrey Manufacturing Co., Columbus, O ... 237

PROCESSES.

Bartlett, Hayward & Co., Baltimore, Md ... 233
United Gas Improvement Co., Phila., Pa ... 227
Burdett Loomis, Hartford, Conn ... 234
National Gas and Water Co., Chicago, Ills ... 229
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 219
The Western Gas Construction Co., Fort Wayne, Ind ... 240
Humphreys & Glasgow, New York City ... 234
Sutherland Construction & Improvement Co., N.Y. City 219
B. E. Chollar, St. Louis, Mo ... 218

SCRUBBERS AND CONDENSERS.

R. D. Wood & Co., Phila., Pa ... 234
Continental Iron Works, Brooklyn, N. Y ... 234
Logan Iron Works, Brooklyn, N. Y ... 236
Riter-Conley Mfg. Co., Pittsburgh, Pa ... 235

TAR AND CARBONIC ACID EXTRACTOR.

R. D. Wood & Co., Phila., Pa ... 234
The Western Gas Construction Co., Fort Wayne, Ind ... 240

AMMONIA CONCENTRATORS.

Michigan Ammonia Works, Detroit, Mich ... 230
American Gas Company, Phila., Pa ... 222
The Western Gas Construction Co., Fort Wayne, Ind ... 240

GAS METERS.

John J. Griffin & Co., Phila., Pa ... 200
American Meter Co., New York and Philadelphia ... 239
Helme & McIlhenny, Phila., Pa ... 239
D. McDonald & Co., Albany, N.Y ... 247
Nathaniel Tufts Meter Co., Boston, Mass ... 238
Maryland Meter and Mfg. Co., Baltimore, Md ... 238
Metric Metal Co., Erie, Pa ... 239
Keystone Meter Co., Royersford, Pa ... 238
Detroit Meter Company, Detroit, Mich ... 239

PREPAYMENT METERS.

American Meter Co., New York and Philadelphia ... 239
John J. Griffin & Co., Phila., Pa ... 200
D. McDonald & Co., Albany, N. Y ... 247
Helme & McIlhenny, Phila., Pa ... 239
Nathaniel Tufts Meter Co., Boston, Mass ... 238

GAS AND WATER PIPES.

M. J. Drummond & Co., New York City ... 224
R. D. Wood & Co., Phila., Pa ... 234
Warren Foundry and Machine Co., New York City ... 224
Donaldson Iron Co., Emaus, Pa ... 224
Christopher Cunningham, Brooklyn, N. Y ... 224
Corneli & Underhill, New York City ... 224

PIPE WRENCHES.

Atlas Pipe Wrench Company, New York City ... 234

GAS MAIN STOPPERS.

Safety Gas Main Stopper Co., N. Y. City ... 230

GAS TAPPING MACHINES.

George Light, Dayton, O ... 237
H. Mueller Manufacturing Company, Decatur, Ills ... 230

GAS COALS.

Penn Gas Coal ... 221
Perkins & Co., New York City ... 230
Despard Gas Coal Co., Baltimore, Md ... 231
Westmoreland Coal Co., Phila., Pa ... 231
Berwind-White Coal Mining Co., New York and Phila ... 230

CANNEL COALS.

Perkins & Co., New York City ... 230

CONVEYORS.

The Link-Belt Machinery Co., Chicago, Ills ... 221
The Western Gas Construction Co., Fort Wayne, Ind ... 240
The Jeffrey Manufacturing Co., Columbus, O ... 237

GAS ENRICHERS.

Standard Oil Co., New York City ... 231
The Sun Oil Co., Pittsburgh, Pa ... 231

COKE CRUSHER.

C. M. Keller, Columbus, Ind ... 231

STEAM BLOWER FOR BURNING BREEZE.
H. E. Parson, Brooklyn, N. Y. ... 221

GAS GAUGES.
The Bristol Co., Waterbury, Conn. ... 22

GAS GOVERNORS.
Connelly Iron Sponge and Governor Co., New York City 229
Isbell-Porter Co., New York City ... 234
R. D. Wood & Co., Phila., Pa. ... 234
Wm. M. Crane Co., New York City ... 221

CEMENTS.
C. L. Gerould, Galesburg, Ills ... 228

RETORTS AND FIREBRICKS.
J. H. Gautier & Co., Jersey City, N. J. ... 228
Adam Weber Sons, New York City ... 228
Laclede Firebrick Mfg. Co., St. Louis, Mo. ... 216 2 28
Cyrus Borgner, Phila., Pa. ... 228
James Gardner, Jr., Co., Pittsburgh, Pa. ... 228
Henry Maurer & Son, New York City ... 228
Baltimore Retort and Firebrick Co., Baltimore, Md. ... 228
Parker-Russell Mining and Mfg. Co., St. Louis, Mo. ... 228
Brooklyn Firebrick Works, Brooklyn, N. Y. ... 228
Missouri Firebrick Co., St. Louis, Mo. ... 228

REGENERATIVE FURNACES.
Bartlett, Hayward & Co., Baltimore, Md. ... 233
Fred. Bredel, Milwaukee, Wis. ... 222
J. H. Gautier & Co., Jersey City, N. J. ... 228
Parker-Russell Mining and Mfg. Co., St. Louis, Mo. ... 228
Adam Weber Sons, New York City ... 228
Missouri Firebrick Co., St. Louis, Mo. ... 228

SELF-SEALING MOUTHPIECE DOORS.
Isbell-Porter Co., New York City ... 234
Continental Iron Works, Brooklyn, N.Y. ... 234
Logan Iron Works, Brooklyn, N. Y. ... 236
R. D. Wood & Co., Phila., Pa. ... 234

CHIMNEY CONSTRUCTION.
Adam Weber Sons, New York City ... 229

INCANDESCENT GAS LAMPS.
Welsbach Company, Gloucester, N.J. ... 226
Kern Incandescent Gas Light Co., New York City. ... 220

BURNERS.
C. A. Gefrorer, Phila., Pa. ... 234
Wm. M. Crane Co., New York City ... 181
D. M. Steward Mfg. Co., Chattanooga, Tenn. ... 221

LAVA GAS TIPS.
D. M. Steward Mfg. Co., Chattanooga, Tenn ... 221

STREET LAMPS.
Welsbach Street Lighting Co., New York and Phila. ... 226
Thos T. W. Miner, New York City ... 230

PURIFIERS.
Stacey Mfg. Co., Cincinnati, O. ... 218

PURIFYING MATERIALS.
Connelly Iron Sponge and Governor Co., New York City 229

VALVES.
Ludlow Valve Manufacturing Co., Troy, N.Y. ... 221
R. D. Wood & Co., Phila., Pa. ... 234
Continental Iron Works, Brooklyn, N. Y. ... 234
The P. H. & F. M. Roots Co., Connersville, Ind. ... 225
Isbell-Porter Co., New York City ... 234
The Western Gas Construction Co., Fort Wayne, Ind. ... 240
Kerr Murray Mfg. Co., Fort Wayne, Ind. ... 232

EXHAUSTERS.
The P. H. & F. M. Roots Co., Connersville, Ind. ... 223
Isbell-Porter Company, New York City ... 234
Connelly Iron Sponge and Governor Co., New York City 229
Kerr Murray Mfg. Co., Fort Wayne, Ind. ... 232

ELECTRICAL APPARATUS.
Wm. Henry White, New York City ... 235

ENGINES AND BOILERS.
The Hazelton Boiler Company, New York City ... 230

PURIFIER SCREENS.
John Cabot, New York City ... 221

GAS STOVES.
American Meter Co., New York and Philadelphia ... 225
Maryland Meter and Manufacturing Co., Baltimore, Md. 228
Keystone Meter Co., Royersford, Pa. ... 238
Nathaniel Tufts Meter Co., Boston Mass. ... 238
George M. Clark & Co., Chicago, Ills. ... 217
Wm. M. Crane Co., New York City ... 217
Detroit Stove Works, Detroit-Chicago ... 197

GASHOLDER TANKS.
J. P. Whittier, Brooklyn, N. Y. ... 233

GASHOLDERS.
Bartlett, Hayward & Co., Baltimore, Md. ... 233
Continental Iron Works, Brooklyn, N. Y. ... 234
Deily & Fowler, Philadelphia, Pa. ... 236
Davis & Farnum Mfg. Co., Waltham, Mass. ... 222
Kerr Murray Mfg. Co., Fort Wayne, Ind. ... 222
Stacey Mfg. Co., Cincinnati, Ohio ... 235
R. D. Wood & Co., Philadelphia, Pa. ... 234
Logan Iron Works, Brooklyn, N. Y. ... 236
Riter-Conley Mfg. Co., Pittsburgh, Pa. ... 235

STORAGE TANKS.
Christopher Cunningham, Brooklyn, N. Y. ... 224

GAS SECURITIES.
Henry Marquand & Co., New York City ... 215

BOOKS, ETC.
Newbigging's Handbook ... 197
Field's Analysis, 1899 ... 236
Scientific Books ... 190
Digest of Gas Cases ... 231
Gas Flow Computers ... 238
Gas Engineer's Laboratory Handbook ... 229
Excerpts from Reports of Gas Commissioners ... 199
Binders ... 224
Directory of Gas Companies ... 235
Practical Handbook on Gas Engines ... 157
Practical Hints on Regenerator Furnaces ... 229
Coal Tar Tree ... 218

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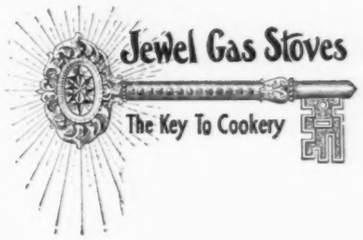

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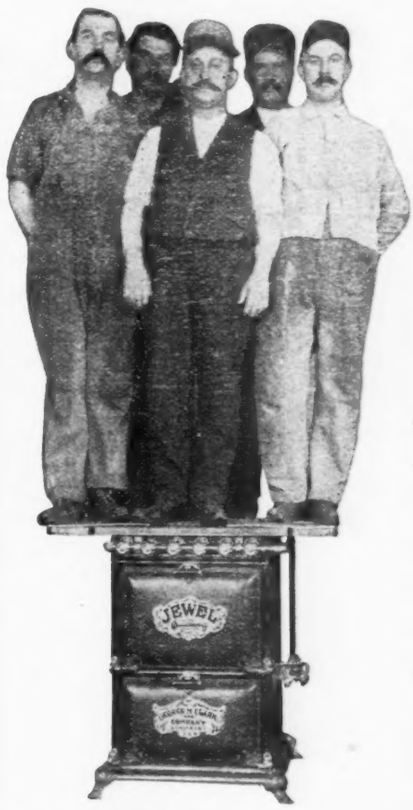

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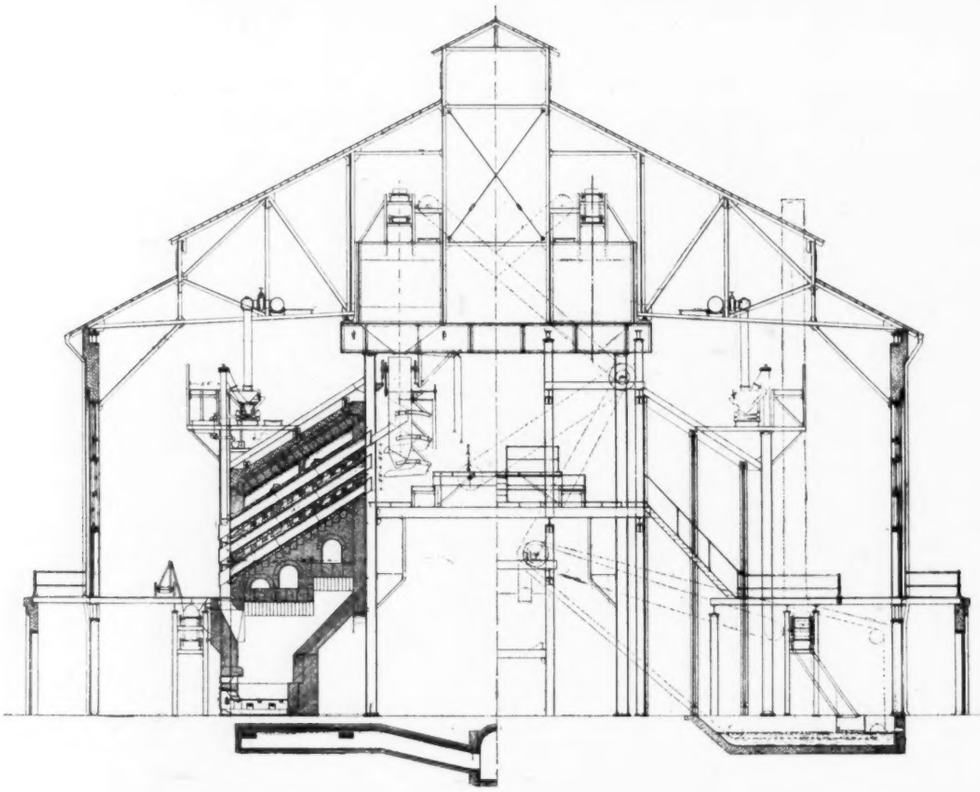

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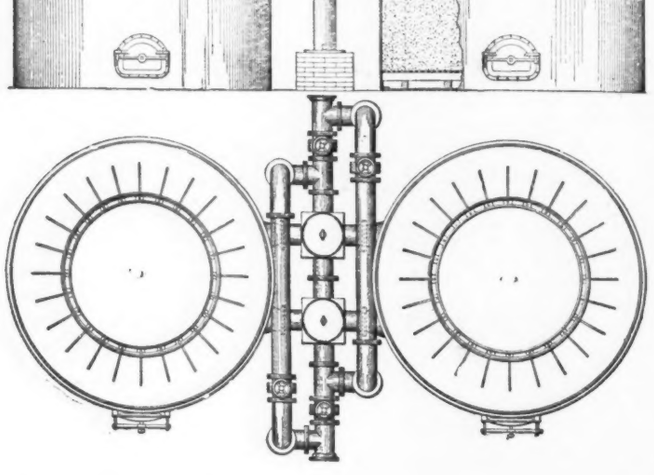

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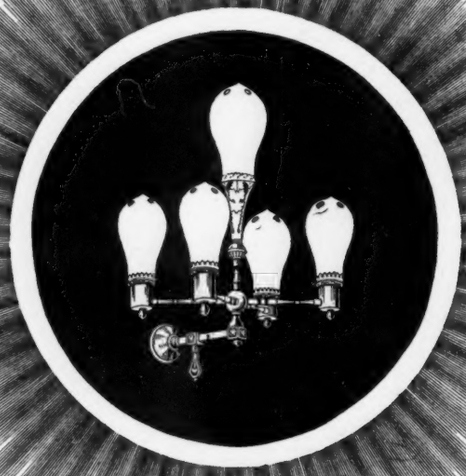

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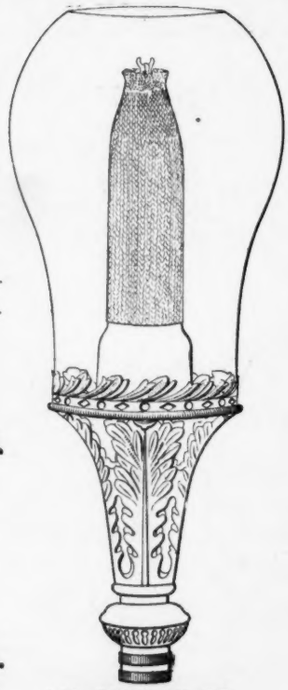

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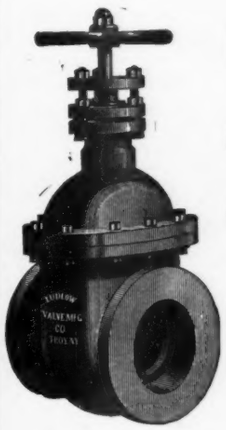

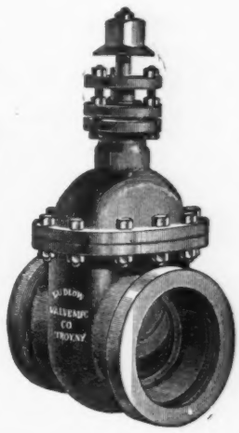

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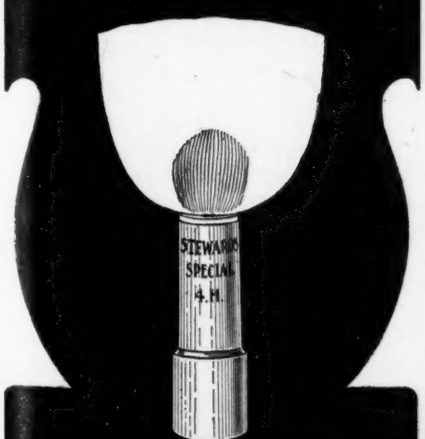

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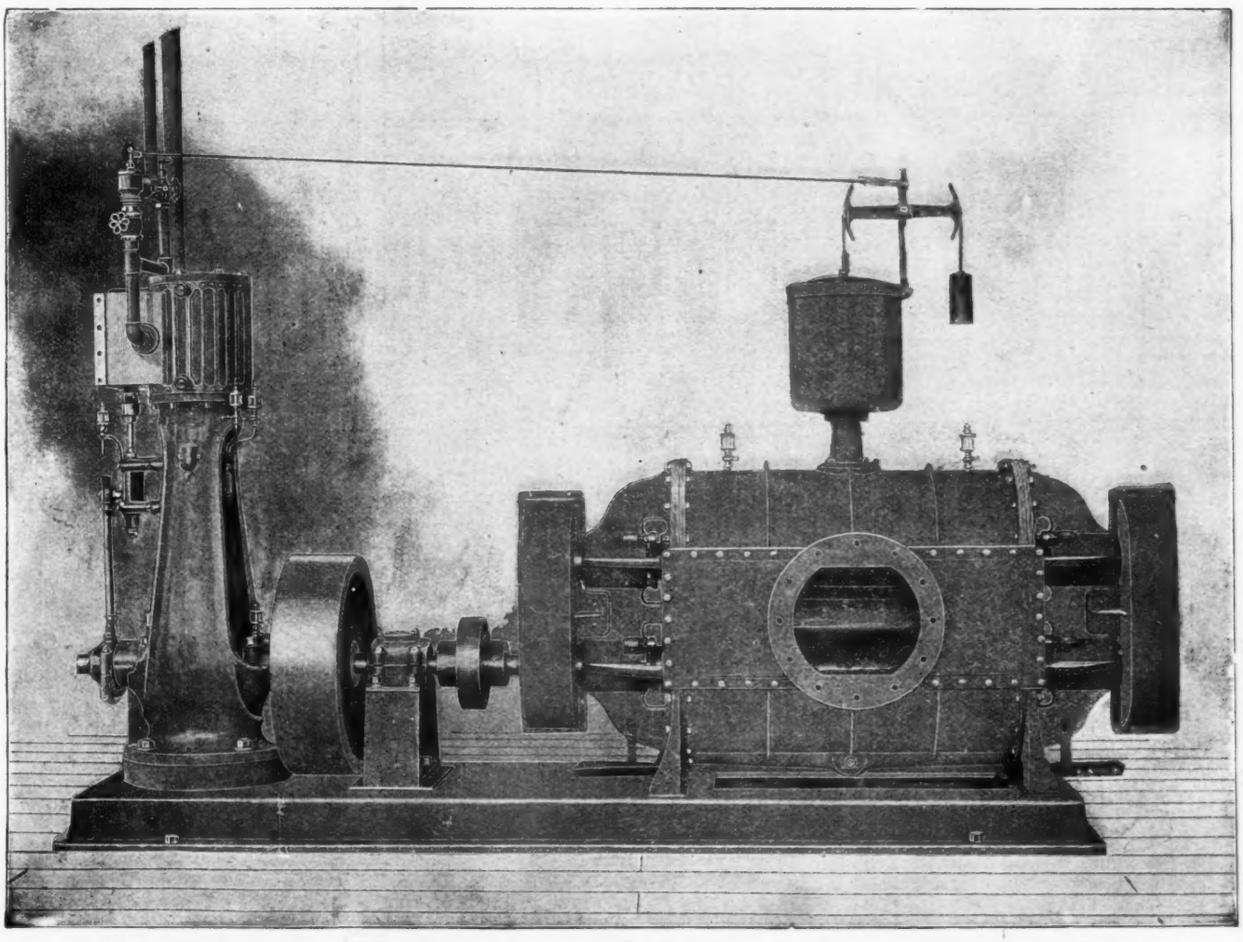

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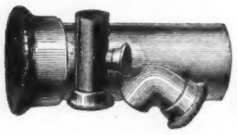

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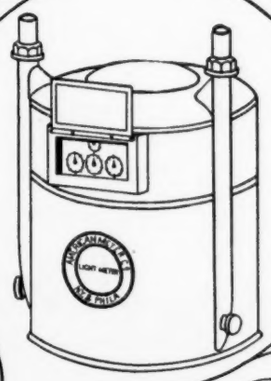

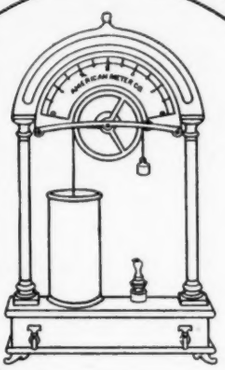

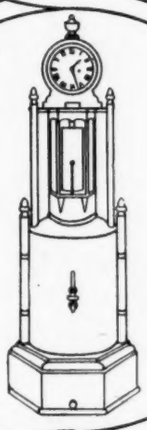

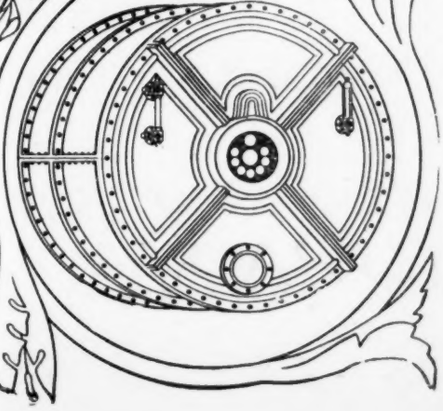

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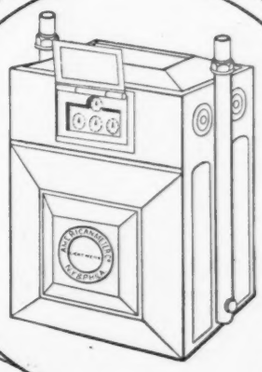
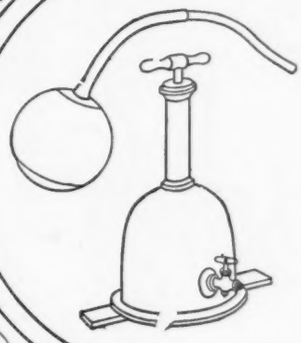
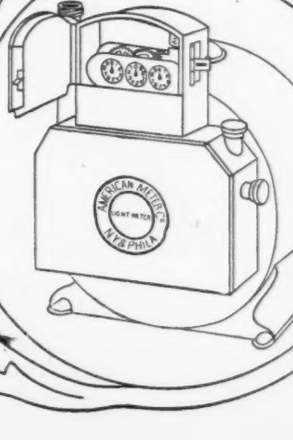






PUBLIC LIGHTING TABLE.

FEBRUARY, 1901.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Fri.	1	5.10 AM	6.10 AM	5.05	6.15
Sat.	2	No L.	No L.	5.05	6.15
Sun.	3	No L. FM	No L.	5.05	6.15
Mon.	4	No L.	No L.	5.05	6.15
Tue.	5	6.00 PM	8.50 PM	5.10	6.10
Wed.	6	6.00	9.40	5.10	6.10
Thu.	7	6.00	10.40	5.10	6.10
Fri.	8	6.00	11.40	5.10	6.10
Sat.	9	6.00	12.30 AM	5.10	6.10
Sun.	10	6.00	1.30	5.10	6.10
Mon.	11	6.00 LQ	2.30	5.10	6.10
Tue.	12	6.00	3.20	5.20	5.55
Wed.	13	6.00	4.10	5.20	5.55
Thu.	14	6.00	5.00	5.20	5.55
Fri.	15	6.00	5.50	5.20	5.55
Sat.	16	6.00	5.50	5.20	5.55
Sun.	17	6.10	5.50	5.20	5.55
Mon.	18	6.10 NM	5.50	5.20	5.55
Tue.	19	6.10	5.50	5.30	5.55
Wed.	20	6.10	5.50	5.30	5.55
Thu.	21	6.10	5.50	5.30	5.55
Fri.	22	6.10	5.50	5.30	5.55
Sat.	23	10.30	5.50	5.30	5.55
Sun.	24	11.40	5.40	5.30	5.55
Mon.	25	12.40 AM FQ	5.40	5.30	5.55
Tue.	26	1.40	5.40	5.30	5.45
Wed.	27	2.30	5.40	5.30	5.45
Thu.	28	3.10	5.40	5.30	5.45

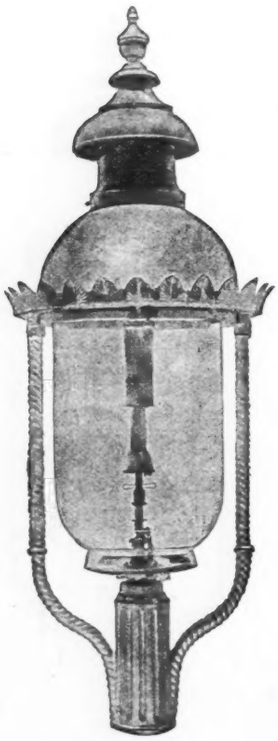
TOTAL HOURS LIGHTING DURING 1901.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	220.10	January	423.20
February	192.30	February	355.25
March	180.00	March	355.35
April	158.30	April	298.50
May	140.40	May	264.50
June	135.40	June	234.25
July	138.00	July	243.45
August	156.20	August	280.25
September	174.40	September	321.15
October	202.30	October	374.30
November	220.40	November	401.40
December	241.30	December	433.45
Total, yr.	2161.10	Total, yr.	3987.45

NEW YORK, 33 Nassau St. PHILADELPHIA, Broad and Arch Sts. CHICAGO, 54 Lake St.

Welsbach Street Lighting Company

.... OF AMERICA ....



No. 36.

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Which includes its specially DESIGNED AND PATENTED BURNER for STREET and PARK LIGHTING exclusively.

Uniformly SUCCESSFUL in seventy-five Cities and Towns.

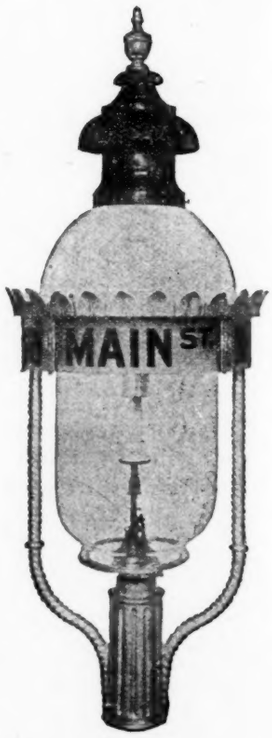
By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

It is { Economical, Attractive, Successful, Up-to-date.

IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.



No. 38.

Correspondence solicited from Gas Companies and others interested in Municipal and outside lighting.

Welsbach Famous Mantles.

THE INCOMPARABLE

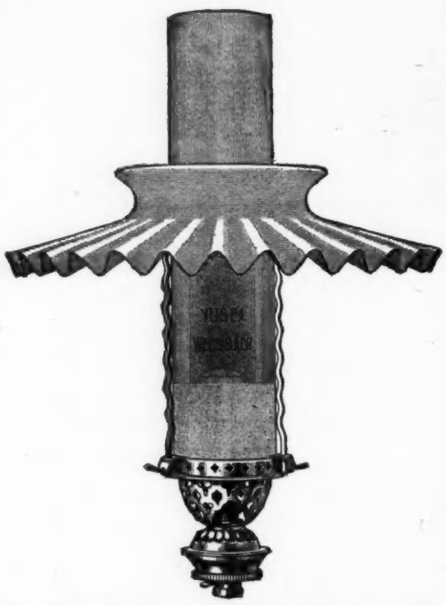
"Yusea" Welsbach Mantle

FINEST EXAMPLE

OF INCANDESCENT

GAS LIGHT

EVER EXHIBITED.



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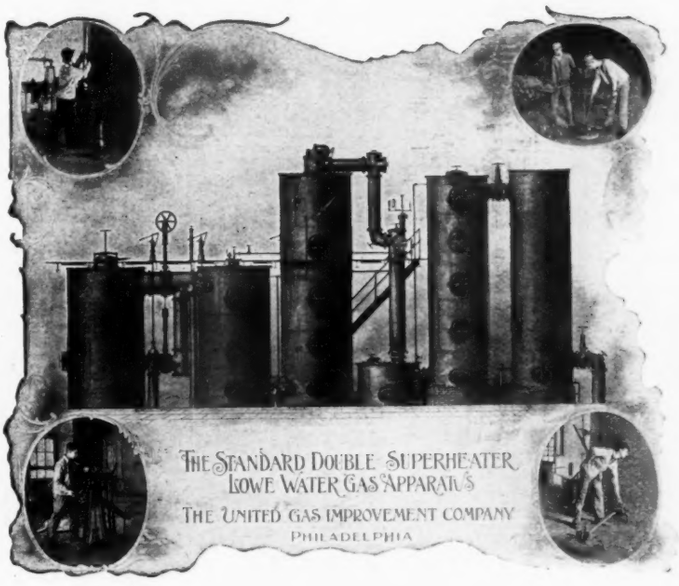
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LOWE WATER GAS APPARATUS
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OFFICE, 418 to 422 East 23d St., N. Y.

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A Cement of great value for patching retorts, putting on mouthpieces, making up all bench-work joints, lining blast furnaces and cupolas. This cement is mixed ready for use. Economic and thorough in its work. Fully warranted to stick.

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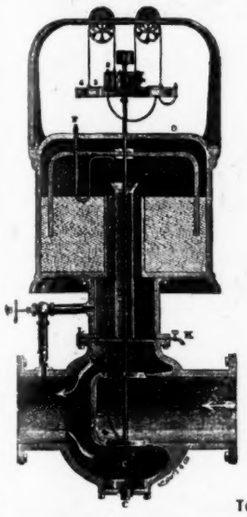

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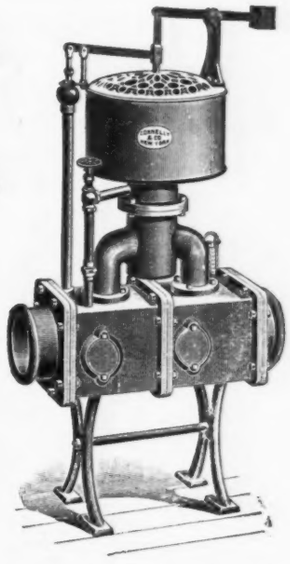

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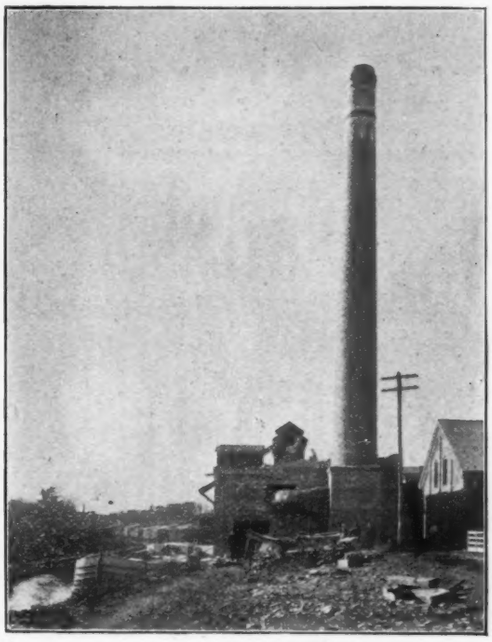

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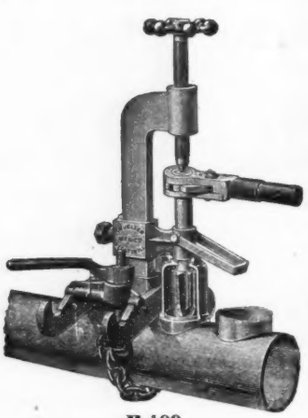

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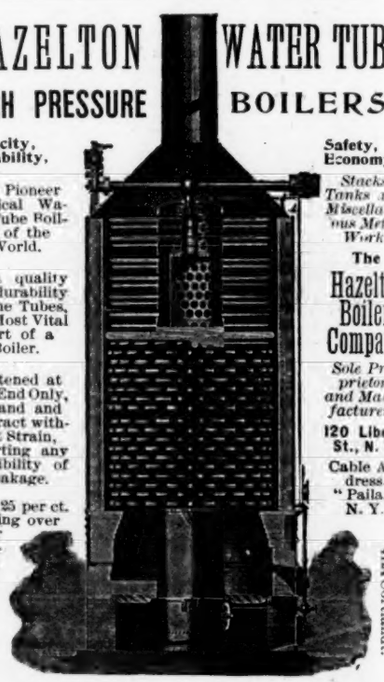

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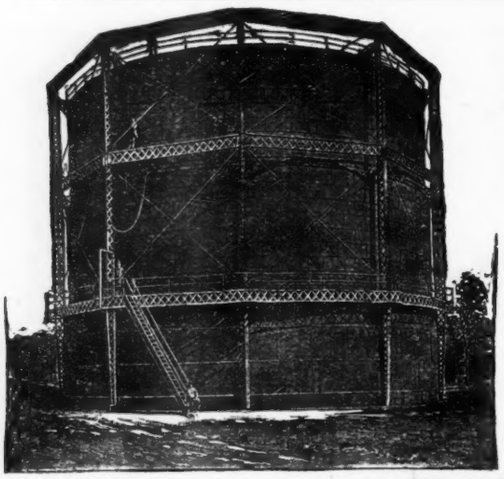

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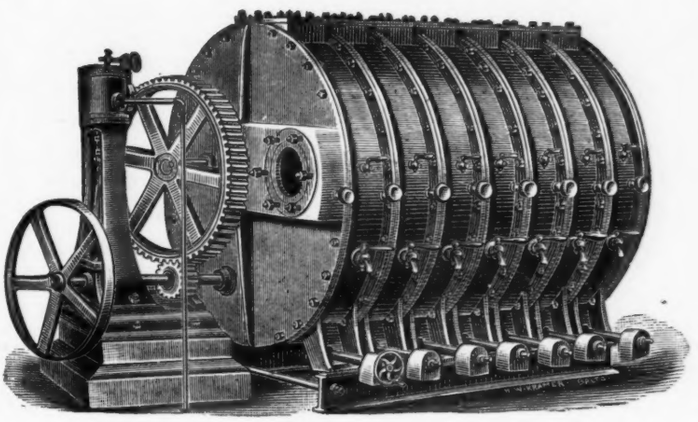

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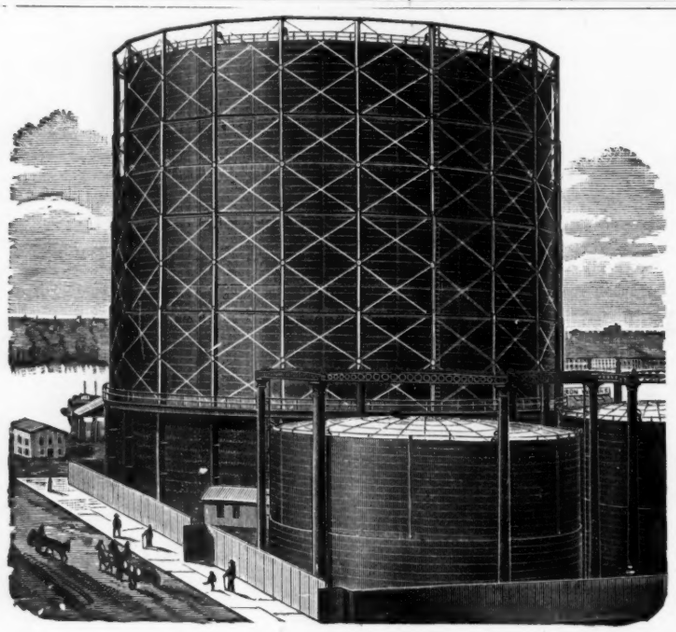

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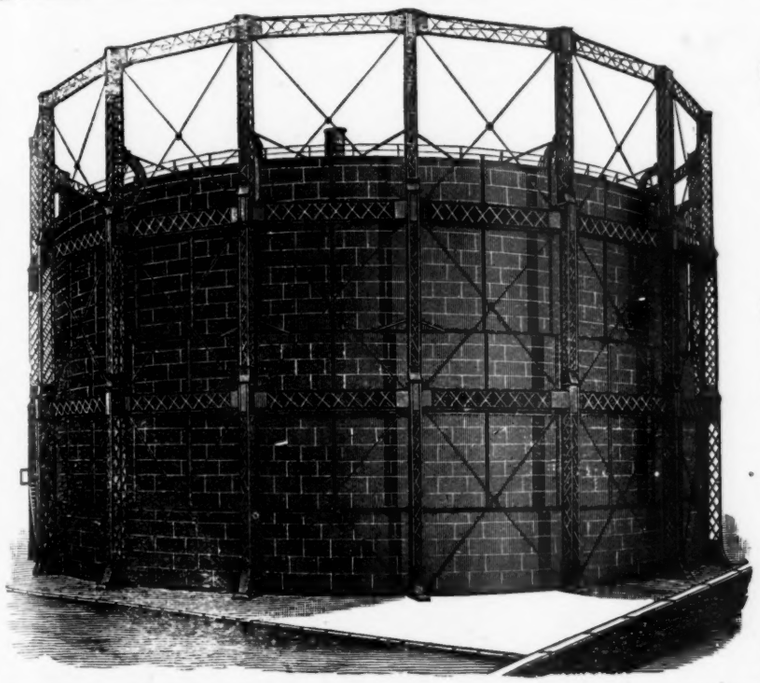

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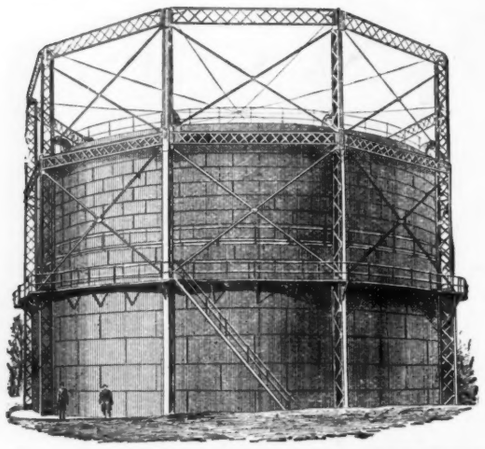

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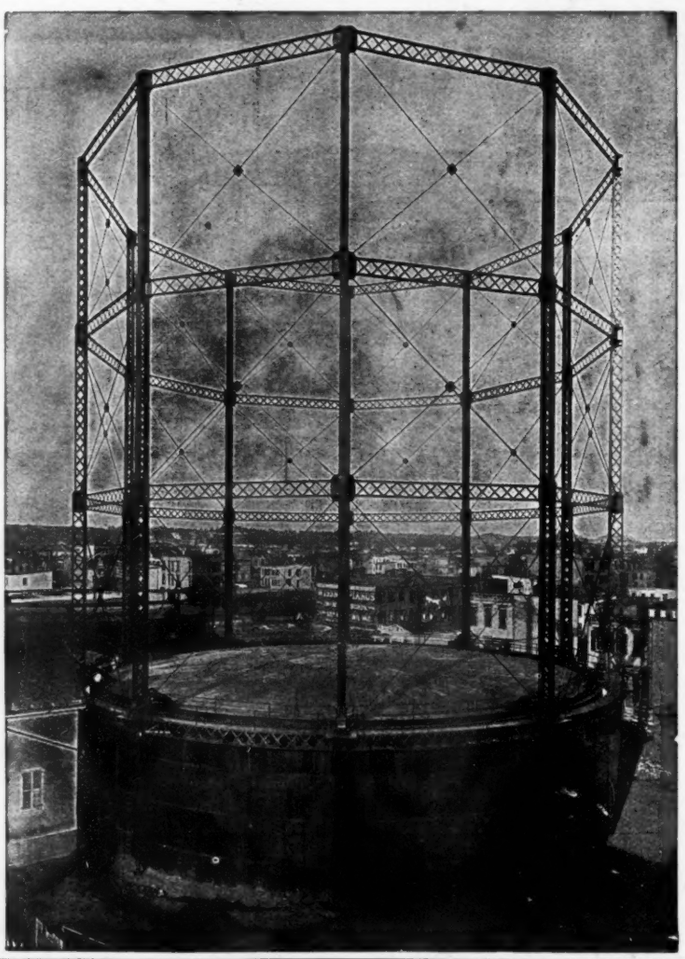

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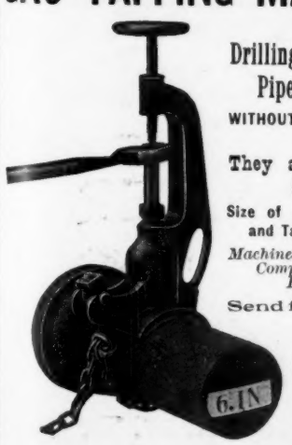

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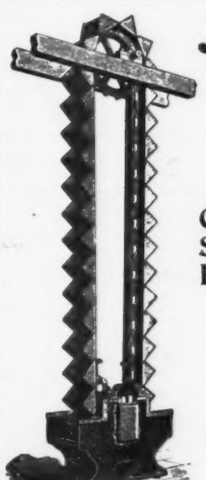

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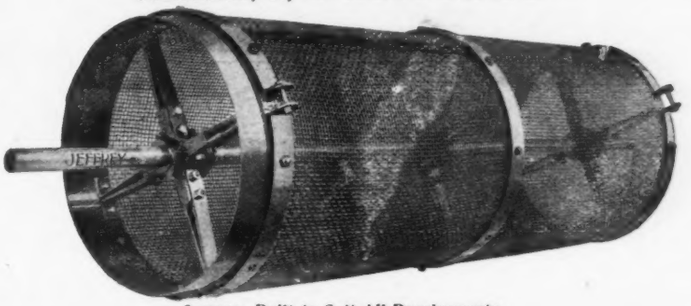

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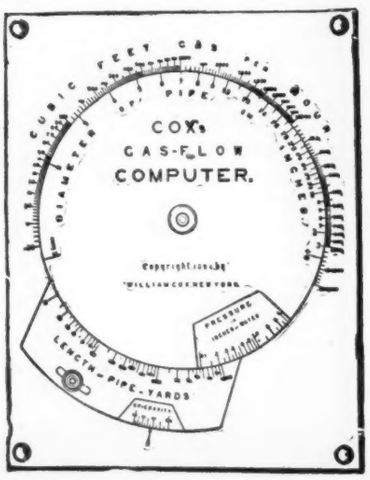

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